6. Energy Supply Planning Model

6.1 Purpose and Model Function

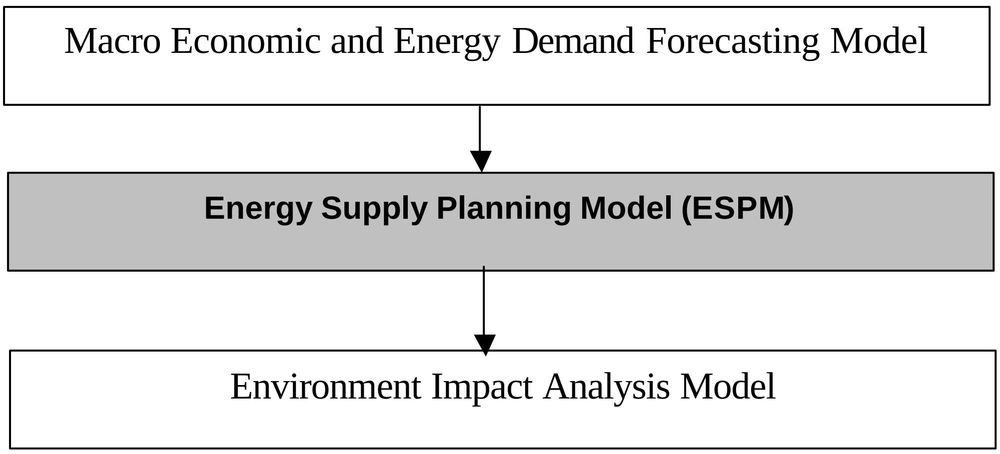
6.1.1 Purpose

The purpose of the supply-planning model is to optimize energy supply balance for energy policy decision-making. The future demand is prepared in the energy demand forecasting model. And shortage and surplus of the energy supply balance is processed in line with the prepared procedures (export for energy supply surplus and import for energy supply shortage). During that time, the energy balance was made up for converging to the maximum profit of energy supply side. The energy supply-planning model (ESPM) aims to optimize the objectives, concerning policy by using the energy prices and demand, estimated in the energy demand forecasting model.

6.1.2 Function

The function of the energy supply-planning model for the whole energy economic model is illustrated in Figure 6.1.1. The forecasting and analysis procedures in the energy economic model are performed in macro economic model, energy demand forecasting model, energy supply planning model and environmental impact analysis model.

Figure 6.1.1 Block Flow of Energy-Economic Model



6.2 Model Concept and Structure

6.2.1 Concept

The Energy Supply Planning Model consists of six EXCEL worksheets. The role of each worksheet is described in the table below. The data output from a worksheet, starting from the price and cost sheet, is processed to the sheet in the next row, which ends with the primary energy supply sheet.

Table 6.2.1 EXCEL Worksheet in ESPM

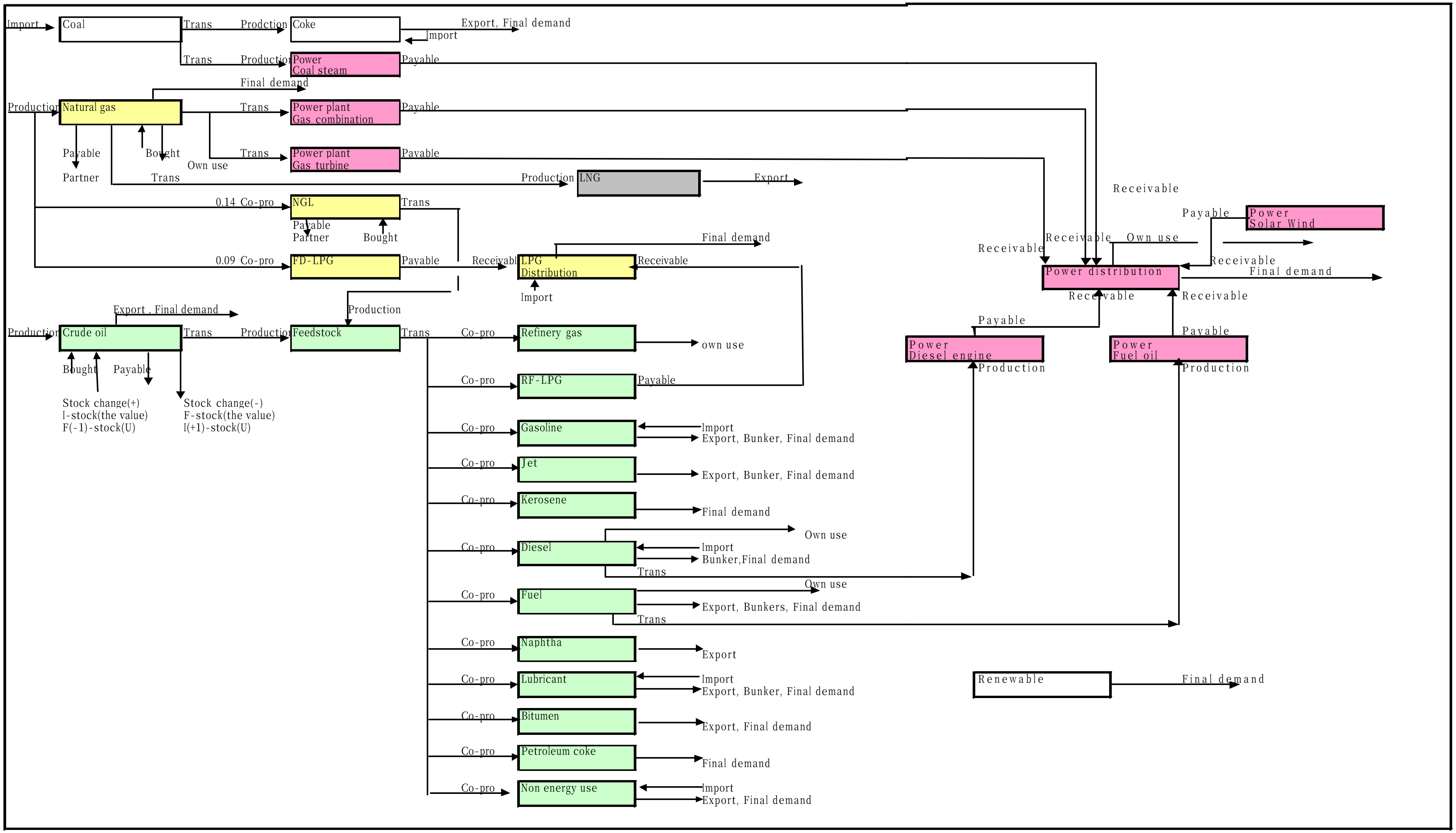
Sheet	Contents
Price and Cost sheet (PIM)	Price and Cost are estimated in the sheet
Input sheet (LIM)	All data are input in the sheet
LP model sheet (LPM)	The sheet is handled by Solver.
Energy balance sheet (EBT)	The sheet is one of the outputs.
Growth rate sheet (GRT)	The sheet is growth rate of "EBT" sheet
Primary energy supply sheet (PEC)	The sheet is one of the outputs.

Regarding ESPM, the model uses linear programming method (LP method) in LPM sheet. (Other sheets do not use LP method). The model in LPM sheet consists of an objective function, variables and constraints. The variables are prepared for all supply and consumption items per energy for targeted years. The constraints give some limitation to the variables. For each constraint, a feasible range for the variable is generated, and LP model searches the optimum solution in the range. The objective function is set in order to search the maximum profit by the LP model.

Table 6.2.2 Components of LP Model in ESPM

Components	Items	Contents
Constraints	Upper limit Lower limit Balance constraints	Constraint supply and consumption items Constraint supply and consumption items Co-products balance, Material balance Transformation, Own use, Stock balance
Variables	Initial-stock Production Import Bought	Supply items
	Receivable Domestic demand Export Bunker oil Payable Finial stock	Consumption items
Objective function	Prices & Cost Income Expense Profit	Prices and cost Calculated by sales and its price Calculated by energy consumption and cost Calculated by income and expense

Figure 6.2.1 Energy Flow for Targeted Energies and Sectors of ESPM



(1) Definition of Energies and Energy Conversion Sectors

Energies and energy conversion sectors in the model are defined in the table below. There are 30 different kinds of energies in 8 energy conversion sectors. Energy conversion sectors consume some types of energy and produce other types of energy.

Table 6.2.4 Energies and Energy Conversion Sectors

Conversion sector	Consumption energies	Energies
Coal sector		Coal
Coke sector	Coal	Coke
Crude oil sector		Crude oil
NG sector		Natural Gas, NGL, LPG (FD), LNG
LPG sector	LPG(FD)、LPG(RF)	LPG
Refinery sector	Crude oil NGL	Refinery feedstock, Refinery gas、LPG (RF)、Gasoline、Jet fuel、Kerosene、Diesel、Fuel oil, Naphtha、Lubricants & additives、Bitumen、Petroleum coke, Non specified products
Power sector	Natural gas Diesel Fuel oil	Power distribution, Hydro, Gas combined, Gas Turbine, Diesel engine, Steam-coal Steam-Fuel oil, Solar-Wind-Others
Renewable		Renewable

LPG (FD) : field LPG, LPG(RF): Refinery LPG

Prepared LNG and Coal steam generator for the future plan

(2) Definition of Supply Items and Consumption Items

The balance between supply and consumption is always maintained through a buffer, such as initial and final stocks. In other words, the total energy consumption, including stock volume, is completely met by the total energy supply. In the model, five items, including Initial-stock, Production, Import, Bought and Receivable, are defined as the supply side. Seven items, including Sales, Export, Bunker, Payable, Transformation, Energy own use and Final- stock, are defined as the consumption side. These items generated the following expression.

Initial - Stock + production + Import + Bought + Receivable
-（Sales + Export + Bunker + Payable + Transformation + Own use + Final-Stock）= 0

And these items have upper limits and lower limits for generating their finite feasible area. The following table shows the relation of the above items (Variables), their upper limits and their lower limits.

Table 6.2.5 Components of Supply and Consumption in ESPM

Side	Variables	Upper Limit	Lower Limit
Supply Side	Initial -Stock	Free	Normally 0
	Production	Capacity Max production	Normally 0 Normally 0
	Import	Max import	Normally 0
	Bought	Max bought	Max bought (*1)
	Receivable	Decided internally	Normally 0
Consumption Side	Sales	Domestic demand	Domestic demand (*2)
	Export	Max export	Normally 0
	Bunkers	Max Bunker sales	Max Bunker sales (*3)
	Payable	Free	Normally 0
	Transformation	Free	Normally 0
	Own use	Free	Normally 0
	Final -Stock	Free (*4)	Normally 0

(*1) Enter Max bought for crude oil, but 0 for NG and NGL

(*2) As Domestic demand is supplied preferentially, should enter the same value in Upper and Lower limit.

(*3) As Bunker oil demand is supplied preferentially, should enter the same value in Upper and Lower limit.

(*4) Enter 0 in final-stock of each year, but should enter 0 in Upper limit of final-stock in the previous year.

(3) Constraints of Energy Balance

1) Energy Transformation Balance

Called "Transformation", some types of energy are converted to other types of energy. Energy transformation sectors calculate the conversion. The following table describes energy transformation sectors, and the energies are calculated in transformation balance expressions.

Table 6.2.6 Energy Transformation Balance

Balance	Conversion sectors	Utilized to
Transformation balance	Coal	Raw material of coke, fuel for power
	Crude oil	Raw material of refinery
	Natural gas	Raw material of LNG, fuel for power
	NGL	Raw material of refinery
	Refinery feedstock	Raw material of refinery
	Diesel	Fuel for power
	Fuel oil	Fuel for power

2) Energy Own Use Balance

Some energy transformation sectors consume the energy that they produced. It is called "Energy own use". Natural gas sector, Refinery sector and Power generation (own use in power generation) and distribution (power loss in delivery) sectors have energy own use. The energy own use are calculated in an energy own use balance.

Table 6.2.7 Energy Sector Use Balance

Balance	Sectors	Consumed energy
Energy own use	Natural gas production sector	Natural gas
	Refinery sector	Refinery gas Diesel Fuel oil Lubricants & additives,
	Electricity sector	Generation loss Distribution loss

3) Co-production Balance

Petroleum plants produce multiple products with some proportion of their yields. It is called "Co-products". Natural gas and Refinery plants have co-products in the model. The production of the co-products is calculated by multiplying main products and their yields. The following table shows co-products in Natural gas and Refinery plants. Co-production is calculated in a co-production balance.

Table 6.2.8 Co-production Balance

Balance	Sector	Produced Energies
Co-production	Natural gas production sector	Natural gas NGL LPG (FD)
	Refinery sector	Refinery Gas LPG (RF) Gasoline Jet fuel Kerosene Diesel Fuel oil Naphtha Lubricants & additives Bitumen Petroleum coke Non specified products

4) Receivable Balance

There are energies to be transferred without the purpose of energy transformation. The received energy is put in Receivable category of its sector. LPG sector receives LPG (FD), which is produced as co-production of Natural gas, and LPG (RF), which is produced as co-produced in Refinery plant. Power distribution sector receives power coming from each power generation sector; power is sold through the power distribution sector.

Table 6.2.9 Receivable Sectors and Payable Sectors

Balance	Receivable Sectors	Payable Sectors
Receivable balance	LPG distribution	LPG (FD) LPG (RF)
	Power distribution	Hydro power Gas combined Gas turbine Coal steam power Diesel engine power Fuel oil steam power Solar, Wind, Others

5) Payable Balance

There are energies to be transferred without the purpose of energy transformation. The paid energy is put in payable category of its sector. The energy to be paid to partners is set in its payable category. The following table shows the relation between the payable sectors and the receivable sectors.

Table 6.2.10 Payable Sector Balance

Balance	Payable sector	Receivable sector
Payable balance	Crude oil	Partner
	Natural gas	Partner
	LPG (FD)	LPG sector
	LPG (RF)	LPG sector
	Power from Hydro	Power distribution sector
	Power from Gas combined	Power distribution sector
	Power from Gas turbine	Power distribution sector
	Power from Coal Steam	Power distribution sector
	Power from Diesel engine	Power distribution sector
	Power from Fuel oil steam	Power distribution sector
	Power from Solar-Wind-Other	Power distribution sector

6) Stock Balance

Initial-stock and Final-stock categories are prepared for their energy stocks in the model. The final-stock of the current year equals to the initial-stock of the next year. Then, the following equation is formulated.

The final-stock of the current year - the initial-stock of the next year = 0

The above equation is formulated in every year for every energy in the model.

(Example) Initial-stock & Final-stock have the same values detected by →

Initial-stock	Initial-stock	Initial-stock	Initial-stock	Initial-stock
1st year	2nd year	3rd year	4th year	5th year
Final-stock	Final-stock	Final-stock	Final-stock	Final-stock

(4) Definition of Objective Function

1) Income Items

Income = Domestic sales value + Export value + Bunker value + Payable value
+ Transportation vale + Own use value + Final stock

2) Expense Items

Expense=Production cost +Import cost + Bought cost + Received cost + Initial stock cost
+ Tax

3) Profit Items

Profit = Income - Expense

6.2.2 Model Structure

(1) Prices and Costs Estimation ("PIM" sheet)

The LP model uses some types of price and cost. Before calculation of the model, the prices and costs of energies should be set. The prices and costs estimation sheet (PIM) are prepared for the purposes. The basic method of the estimation is "Price net back method", in which primary energy and intermediate petroleum product prices are estimated by market prices of domestic energy demand.

1) Exogenous Variables

Crude oil price ($/bbl), Coal price ($/ton), WPI (1996=100) and Exchange rate (LE/$) are used for estimating energy price and cost as exogenous variables in the model. The exogenous variables are estimated in a macro economic model. Also, energy import prices are calculated with the difference between domestic crude oil price and international crude oil price. Then, the difference between two crude oils is calculated in the exogenous variable block.

2) Crude Oil

Partner cost is defined as "Plant cost * Partner share". Plant cost is calculated as the following table. At first, the crude oil production cost in 1999 is estimated as 10 US$/bbl. The calculation of crude oil plant cost starts with the crude oil production cost.

Table 6.2.11 Plant Cost Estimation of Crude Oil in "PIM" Sheet

Items	Unit in 1999	Comments
Estimated crude oil production cost, 10US$/bbl	10US$/bbl	
LE/bbl	34LE/bbl	10US$*Exchange
LE/TON	250LE/TON	34/0.159/0.85
Plant cost	178LE/TON	250/(1+patner share)
Partner share cost	70LE/TON	

Energy import cost is calculated as international crude oil price. And Bought cost is calculated from the expression of "Production cost *1.1". The consumption ratio of domestic production crude oil and bought crude oil is 0.8:0.2.

Table 6.2.12 Prices and Cost Estimation of Crude Oil in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Crude oil PC	Cost	Partner cost	LE/TON	62.1	68.8	70.9	Plant cost * Partners share
		Plant cost	LE/TON	167.3	172.0	177.2	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	229.4	240.9	248.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	225.6	320.2	449.4	International coal price * Exchange rate
		Bought cost	LE/TON	252.3	264.9	272.8	Production cost *1.1
		Average cost	LE/TON	234.0	245.7	253.0	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	20.0	20.0	20.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	280.8	294.8	303.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	60.0	70.0	70.0	
		TAX rate for Domest	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	374.3	417.6	430.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	60.0	100.0	100.0	
		Sales price of Export	LE/TON	374.3	491.3	505.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	70.0	70.0	70.0	
		Sales price of Bunkers	LE/TON	397.7	417.6	430.1	Average cost*(1+ROI/100)

3) Natural Gas

Domestic market price in 1999 is 185LE/TON. Then, we can estimate plant cost and partner share cost in line with the following table.

Table 6.2.13 Plant Cost Estimation of Natural Gas in "PIM" Sheet

Items	Unit in 1999	Comments
Domestic market price in 1999	185LE/TON	
Average cost (before ROI=15%)	160LE/TON	185/(1+0.2)
Production cost	157LE/TON	160=P*0.8+1.1*P*0.2
Plant cost	120LE/TON	157/(1+0.3): Partner share
Partner share cost	37LE/TON	

Energy import cost is calculated as international crude oil price / domestic crude oil price. Bought cost is calculated from the expression of "Production cost * 1.1". The ratio of domestic natural gas and bought natural gas is 0.8:0.2.

Table 6.2.14 Prices and Cost Estimation of Natural Gas in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Natural gas PC	Cost	Partner cost	LE/TON	32.7	34.4	35.4	Plant cost * Partners share
		Plant cost	LE/TON	111.5	114.7	118.1	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	144.2	149.1	153.5	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	158.6	164.0	168.9	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	158.6	164.0	168.9	Production cost *1.1
		Average cost	LE/TON	147.1	152.1	156.6	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	15.0	15.0	15.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	169.2	174.9	180.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	15.0	15.0	15.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	169.2	174.9	180.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	15.0	15.0	15.0	
		Sales price of Export	LE/TON	169.2	174.9	180.1	Average cost*(1+ROI/100)
		ROI for Bunkers	%	15.0	15.0	15.0	
		Sales price of Bunkers	LE/TON	169.2	174.9	180.1	Average cost*(1+ROI/100)
		Slaes price of Domestic market		175.0	187.0	200.0	

4) NGL

An assumption is set that NGL domestic price in 1999 equals to crude oil price of 10US$/bbl in 1999. Under the assumption, it is possible to calculate NGL plant cost and partner share cost.

Table 6.2.15 Plant Cost Estimation of NGL in "PIM" Sheet

Items	Unit in 1999	Comments
NGL domestic price (Assumption)	10US$/bbl	
LE/bbl	34LE/bbl	10US$*Exchange
LE/TON	250LE/TON	34/0.159/0.85
Plant cost	190LE/TON	250/(1+0.32patner share)
Partner share cost	60LE/TON	

Table 6.2.16 Prices and Cost Estimation of NGL in "PIM" Sheet

G	H	I	J	1998	1999	2000	
NGL PC	Cost	Partner cost	LE/TON	55.5	58.7	60.5	Plant cost * Partner share
		Plant cost	LE/TON	178.5	183.5	189.0	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	234.0	242.2	249.4	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	257.4	266.5	274.4	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	257.4	266.5	274.4	Production cost *1.1
		Average cost	LE/TON	238.6	247.1	254.4	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	10.0	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	262.5	271.8	279.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	262.5	271.8	279.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/TON	262.5	271.8	279.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/TON	262.5	271.8	279.9	Average cost*(1+ROI/100)

5) LPG Distribution

LPG is produced in FD-LPG and RF-LPG and sent to LPG distribution. The variable cost of LPG distribution is the weighted average of the FD-LPG and RF-LPG.

Table 6.2.17 Prices and Cost Estimation of LPG Distribution in "PIM" Sheet

G	H	I	J	1998	1999	2000	
LPG distribut PC	Cost	Variable cost	LE/TON	198.6	205.3	211.4	0.8*FD-LPG invoice price + 0.2*RF-invoice price
		Plant cost	LE/TON	0.0	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	198.6	205.3	211.4	Partner cost + Plant cost + Other cost
		Import cost	LE/TON	218.4	225.8	232.6	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0	0.0
		Average cost	LE/TON	198.6	205.3	211.4	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	208.5	215.6	222.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	5.0	5.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	208.5	215.6	222.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	5.0	
		Sales price of Export	LE/TON	208.5	215.6	222.0	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	5.0	
		Sales price of Bunkers	LE/TON	208.5	215.6	222.0	Average cost*(1+ROI/100)
		Slaes price of Domestic market		200.0	213.7	228.6	

6) Gasoline

Petroleum products are separated to Co-products and By-products in the accounting system. The main petroleum products (gasoline, Jet fuel, kerosene, diesel, naphtha, lubricants & additives) are classified as Co-products. Others are By-products. Co-products can be added up to the full cost (variable cost and plant cost) of refinery plant, but By-products can not be added up to the full cost of refinery plant because their market prices are lower than their full cost. Usually, By-products are only added up to the variable cost.

Table 6.2.18 Plant Cost Estimation of Refinery in "PIM" Sheet

Items	Unit	Comments
Plant investment	3400 million LE	1000 million US$
6 Capacity	3 million TON	
Depreciation years	10 years	
Depreciation	340 million LE	
Fixed cost	239LE/TON	Depreciation/Capacity/Co-products
Plant cost	240LE/ton	

Table 6.2.19 Refinery Cost Distribution in "PIM" Sheet

Energies	Yields	By-Co	By-yields	Co-yields	PlantCost	VariableCost(Even)		VariableCost(Weighted)	
Refinery Gas	0.0000	BY	0.0000			280	0.0	280	0.0
RF-LPG	0.0160	By	0.0160			280	4.5	280	4.5
Gasoline	0.0730	Co		0.0730	240.0	280	20.4	1120	81.8
Jet fuel	0.0330	Co		0.0330	240.0	280	9.2	280	9.2
Kerosene	0.0450	Co		0.0450	240.0	280	12.6	280	12.6
Diesel	0.2060	Co		0.2060	240.0	280	57.7	280	57.7
Fuel oil	0.4590	By	0.4590			280	128.5	140	64.3
Naphtha	0.0940	C0		0.0940	240.0	280	26.3	280	26.3
Lubricants & additive	0.0090	Co		0.0090	240.0	280	2.5	280	2.5
Bitumen	0.0260	By	0.0260			280	7.3	280	7.3
Petroleum Coke	0.0050	By	0.0050			280	1.4	280	1.4
Non specified produc	0.0060	By	0.0060			280	1.7	280	1.7
Total	0.972		0.512	0.460		3360	272.2		269.2
Total=1.000	1.000		0.527	0.473					

The above Plant cost (240LE/TON) is added up to Co-products (Gasoline, Jet fuel, Kerosene, Diesel, Naphtha, Lubricants & additives), but it is not added up by By-products. Variable cost is mainly crude oil price. Fuel oil can only be added up to half of variable cost. Then gasoline has to be added up to its variable cost and half of variable cost of fuel oil.

Variable cost of gasoline is 1,120LE/TON
Variable cost of Fuel oil is 140LE/TON.
Variable cost of Other is 280LE/TON.

Table 6.2.20 Prices and Cost Estimation of Gasoline in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Gasoline PC	Cost	Variable cost	LE/TON	1,115.7	1,170.0	1,204.8	Feedstock invoice price *4
		Plant cost	LE/TON	227.2	233.6	240.6	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	1,343.0	1,403.7	1,445.4	Partner cost + Plant cost + Other cost
		Import cost	LE/TON	1,477.2	1,544.0	1,589.9	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0	0.0
		Average cost	LE/TON	1,343.0	1,403.7	1,445.4	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	1,477.2	1,544.0	1,589.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	1,477.2	1,544.0	1,589.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/TON	1,477.2	1,544.0	1,589.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/TON	1,477.2	1,544.0	1,589.9	Average cost*(1+ROI/100)
		Slaes price of Domestic market		1,305.0	1,394.5	1,491.6	

7) Kerosene

In the model, kerosene is defined as Co-product. Then, kerosene is added up to plant cost as well as gasoline. Regarding the variable cost, gasoline is added up to its variable cost and part of variable cost of fuel oil. However, kerosene is added up to only its variable cost (feedstock invoice price).

Table 6.2.21 Prices and Cost Estimation of Kerosene in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Kerosene PC	Cost	Variable cost	LE/TON	278.9	292.5	301.2	Feedstock invoice price
		Plant cost	LE/TON	227.2	233.6	240.6	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	506.2	526.2	541.8	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	556.8	578.8	596.0	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0	0.0
		Average cost	LE/TON	506.2	526.2	541.8	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	531.5	552.5	568.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	5.0	5.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	531.5	552.5	568.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	5.0	
		Sales price of Export	LE/TON	531.5	552.5	568.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	5.0	
		Sales price of Bunkers	LE/TON	531.5	552.5	568.9	Average cost*(1+ROI/100)
		Slaes price of Domestic market		504.0	538.6	576.1	

8) Diesel

In the model, diesel is defined as Co-product. Then, diesel is added up to plant cost as well as gasoline. Regarding the variable cost, gasoline is added up to its variable cost and part of variable cost of fuel oil. However, diesel is added up only its variable cost (feedstock invoice price).

Table 6.2.22 Prices and Cost Estimation of Diesel Oil in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Diesel PC	Cost	Variable cost	LE/TON	283.4	297.2	306.0	Feedstock invoice price *(1+Own use yield)
		Plant cost	LE/TON	227.2	233.6	240.6	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	510.6	530.8	546.6	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	561.7	583.9	601.3	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0	0.0
		Average cost	LE/TON	510.6	530.8	546.6	Production cost
	Prices	ROI for Invoice	%	-50.0	-50.0	-50.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	255.3	265.4	273.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	561.7	583.9	601.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/TON	561.7	583.9	601.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/TON	561.7	583.9	601.3	Average cost*(1+ROI/100)
		Slaes price of Domestic market		504.0	538.6	576.1	

9) Fuel Oil

In the model, fuel oil is defined as By-product. Then fuel oil does not add up to any plant cost. Regarding the variable cost, fuel oil market price is low. Hence, fuel oil can not be added up to the full variable cost. In the model, variable cost of fuel cost is half of feedstock invoice cost. By doing so, fuel oil can have market competitiveness as fossil energy.

Table 6.2.23 Prices and Cost Estimation of Fuel Oil in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Fuel oil PC	Cost	Variable cost	LE/TON	142.1	149.0	153.5	(Feedstock invoice price)/2*(1+Own use yield)
		Plant cost	LE/TON	0.0	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0	0.0
		Production cost	LE/TON	142.1	149.0	153.5	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	156.3	163.9	168.8	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0	0.0
		Average cost	LE/TON	142.1	149.0	153.5	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/TON	156.3	163.9	168.8	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/TON	156.3	163.9	168.8	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/TON	156.3	163.9	168.8	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/TON	156.3	163.9	168.8	Average cost*(1+ROI/100)
		Slaes price of Domestic market		182.0	194.5	208.0	

10) Power Distribution

Power distribution receives power from Hydro-power, Gas combined cycle, Coal fired thermal power, Diesel oil fired thermal power, Fuel oil fired thermal power and Solar-Wind-Other power generation. The weight of power in 1999 is the follows:

Hydro power --- 0.2

Gas combined cycle ------------------------------------ 0.4

Coal fired thermal power ------------------------------ -0.0

Diesel oil fired thermal power ------------------------ 0.1

Fuel oil fired thermal power ----------------------------0.3

Solar-Wind-Other power ------------------------------- 0.0

Variable cost of power distribution sector is the invoice cost from these power generation. And fixed cost is not accounted because power distribution does not generate any fixed cost.

Table 6.2.24 Prices and Cost Estimation of Power Distribution in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Power distrib PC	Cost	Variable cost	LE/MWh	150.2	152.7	157.2	Hydroinvoice *0.2+Gas combined invoice*0.4+Coal s
		Plant cost	LE/MWh	0.0	0.0	0.0	0.0
		Other cost	LE/MWh	0.0	0.0	0.0	0.0
		Production cost	LE/MWh	150.2	152.7	157.2	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	165.2	167.9	172.9	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/MWh	0.0	0.0	0.0	0.0
		Average cost	LE/MWh	150.2	152.7	157.2	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/MWh	157.7	160.3	165.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	5.0	5.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/MWh	157.7	160.3	165.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	5.0	
		Sales price of Export	LE/MWh	157.7	160.3	165.1	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	5.0	
		Sales price of Bunkers	LE/MWh	157.7	160.3	165.1	Average cost*(1+ROI/100)
		Slaes price of Domestic market (fo		132.7	141.8	151.7	

11) Hydro Power

Variable cost of Hydro-power generation is zero. Yet, it is estimated that the plant cost of Hydro-power is high, compared to other types of power generation. Then it is estimated by using plant cost of other types of power generation.

Table 6.2.25 Plant Cost Estimation of Power Generation in "PIM" Sheet

Generators	Unit in 1999	Comments
Power fee in Egypt (for industry)	132LE/MWh	
Power production cost in Egypt	115LE/MWh	132/(1+0.15) ,0.15=ROI
Variable cost of Gas combined	34LE/MWh	
Variable cost of Coal steam	31LE/MWh	
Variable cost of Gas turbine	62LE/MWh	
Variable cost of Diesel engine	72LE/MWh	
Variable cost of Fuel oil	43LE/MWh	
Variable cost of Hydro	0LE/MWh	
Plant cost of Gas combined	80LE/MWh	Round number
Plant cost of Coal steam	90LE/MWh	Round number
Plant cost of Gas turbine	70LE/MWh	Round number
Plant cost of Diesel engine	60LE/MWh	Round number
Plant cost of Fuel oil	80LE/MWh	Round number
Plant cost of Hydro	150LE/MWh	Double of other plant cost

Using the above table, plant cost of hydro-power generator is estimated to be 150LE/MWh in 1999.

Table 6.2.26 Prices and Cost Estimation of Hydro Power in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Power Hydro PC	Cost	Variable cost	LE/MWh	0.0	0.0	0.0	0.0
		Plant cost	LE/MWh	144.1	148.2	152.6	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0	0.0
		Production cost	LE/MWh	144.1	148.2	152.6	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0	0.0
		Average cost	LE/MWh	144.1	148.2	152.6	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/MWh	158.5	163.0	167.8	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/MWh	158.5	163.0	167.8	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/MWh	158.5	163.0	167.8	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/MWh	158.5	163.0	167.8	Average cost*(1+ROI/100)

12) Gas Combined Cycle

Variable cost of gas combined cycle is the natural gas invoice price with its efficiency. According to the power plant cost calculation table above, plant cost of gas combined cycle is estimated to be 80LE/MWh.

Table 6.2.27 Prices and Cost Estimation of Gas Combined Cycle in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Power Gas c PC	Cost	Variable cost	LE/MWh	31.0	32.0	33.0	Natural gas invoice price / Efficiency *(1+Own use yie
		Plant cost	LE/MWh	77.6	79.8	82.2	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0	0.0
		Production cost	LE/MWh	108.6	111.8	115.1	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0	0.0
		Average cost	LE/MWh	108.6	111.8	115.1	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/MWh	119.4	123.0	126.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/MWh	119.4	123.0	126.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/MWh	119.4	123.0	126.7	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/MWh	119.4	123.0	126.7	Average cost*(1+ROI/100)

13) Fuel Oil Fired Thermal Power

Variable cost of Fuel oil thermal power is the fuel oil invoice price with its efficiency. According to the power plant cost calculation table above, plant cost of Fuel oil thermal power is 80LE/MWh.

Table 6.2.28 Prices and Cost Estimation of Fuel Oil Fired Power in "PIM" Sheet

G	H	I	J	1998	1999	2000	
Power Fuel o	Cost	Variable cost	LE/MWh	38.8	40.6	41.9	Fuel oil invoice price / Efficiency *(1+Own use yield)
PC		Plant cost	LE/MWh	79.8	82.1	84.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0	0.0
		Production cost	LE/MWh	118.6	122.7	126.4	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0	0.0
		Average cost	LE/MWh	118.6	122.7	126.4	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	0.0	
		Invoice price	LE/MWh	130.4	135.0	139.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	0.0	
		Sales price of Domestics	LE/MWh	130.4	135.0	139.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	10.0	
		Sales price of Export	LE/MWh	130.4	135.0	139.0	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	10.0	
		Sales price of Bunkers	LE/MWh	130.4	135.0	139.0	Average cost*(1+ROI/100)

(2) Energy Data Input and Formation ("LIM" sheet)

The following table is a sample of input format (for Crude oil). The input format is divided into a supply side and a consumption side. The supply items consist of Capacity, Initial stock, Production, Import, Bought and Receivable. The consumption items consist of Final demand, Export, Bunkers, Payable, Transformation, Energy sector use (Own use) and Final stock. Each input item has three lines--upper limit line, solution line and lower limit line. The input data are entered in the upper limit and the lower limit lines. The solution data come from LP matrix ("LPM" sheet) and are set in the solution lines.

1) Capacity

Production capacity of each energy is set in the upper limit. The lower limit of the production capacity usually has the value of 0. The operation rate to a production capacity is calculated by using the production capacity and its production volume.

(Operation rate = Production volume / Production capacity*100)

2) Initial-Stock

The initial-stock usually has the value of 0. Especially, the initial-stock of the beginning of the year should have 0 or some value. When there is stock change with a (+) sign in the energy balance table, the value should be set in the initial-stock area. If the initial-stock does not have any value after the second year, the initial-stock should be set to "U", meaning infinite.

Table 6.2.29 Data Input Formation of "ESPM"

ITEMS 1	ITEMS 2	SECTORS		UNIT	1998	1999	2000	2001	2002	2003	2004
Crude oil	Supply	Capacity of production	Upper Limit	KTON	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
			Operation	%	89.5	97.6	100.0	99.8	98.1	96.3	94.1
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Initial-Stock=Stock Chan	Upper Limit	KTON	U	U	U	U	U	U	U
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production=Indigenous(+	Upper Limit	KTON	39,516.0	39,496.0	40,034.0	40,532.0	40,999.0	41,441.0	41,865.0
		1.00	Solution	KTON	35,796.2	39,053.0	40,000.0	39,906.7	39,251.8	38,502.7	37,657.2
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Import	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	Upper Limit	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
			Solution	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
			Lower Limit	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
		Receivables=Transfer(+)	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		fm Differences	Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	Upper Limit	KTON	45576.0	45596.0	46134.0	46632.0	47099.0	47541.0	47965.0
			Solution	KTON	41856.2	45153.0	46100.0	46006.7	45351.8	44602.7	43757.2
			Lower Limit	KTON	6060.0	6100.0	6100.0	6100.0	6100.0	6100.0	6100.0
Crude oil	Consumption	Final Demand	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	Upper Limit	KTON	2,934.0	2,351.0	2,130.0	1,845.0	1,506.0	1,113.0	665.0
			Solution	KTON	2,934.0	2,351.0	2,130.0	1,845.0	1,506.0	1,113.0	665.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bunkers	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable=Transfer(-),Part	Upper Limit	KTON	U	U	U	U	U	U	U
			Solution	KTON	13,280.4	15,621.2	16,000.0	15,962.7	15,700.7	15,401.1	15,062.9
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Transformation=Transfor	Upper Limit	KTON	U	U	U	U	U	U	U
			Solution	KTON	25,641.8	27,180.8	27,970.0	28,199.0	28,145.1	28,088.6	28,029.3
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Energy Sector =Energy S	Input	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Final-Stock=Stock Chang	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	Upper Limit	KTON	2934.0	2351.0	2130.0	1845.0	1506.0	1113.0	665.0
			Solution	KTON	41856.2	45153.0	46100.0	46006.7	45351.8	44602.7	43757.2
		66092	Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude oil	Prices	Production cost	75.0	KLE/KTON	229.4	240.9	248.0	255.1	262.0	268.9	275.7
		Import cost	76.0	KLE/KTON	225.6	320.2	449.4	480.8	513.9	548.9	586.1
		Bought cost	77.0	KLE/KTON	252.3	264.9	272.8	280.6	288.2	295.8	303.3
		Invoice price	81.0	KLE/KTON	280.8	294.8	303.6	312.2	320.7	329.1	337.5
		Sales price of Domestics	84.0	KLE/KTON	374.3	417.6	430.1	442.3	454.3	466.2	478.1
		Sales price of Export	86.0	KLE/KTON	374.3	491.3	505.9	520.4	534.5	548.5	562.5
		Sales price of Bunkers	88.0	KLE/KTON	397.7	417.6	430.1	442.3	454.3	466.2	478.1

3) Production

The upper limit and the lower limit of the production are set from the energy balance table. The upper limit and the lower limit of the production, as well as those of the capacity constrains the production variable in the model.

4) Import

For import area, the upper limit and lower limit are set from the energy balance table. But when the energy is short for the demand, the energy has to be imported. Then, the upper limit of import is usually set to "U" (Infinite), and the lower limit is set to 0. In the above sample of crude oil, every upper limit is set to 0 because crude oil is not permitted to be imported in the targeted years (In the future, though, it is possible to import crude oil).

5) Bought

For Bought area, the upper limit and lower limit of Bought are set from the energy balance table. The volume of natural gas and NGL from partners can be bought as much as the volume is paid to partners. Then the Bought of the two energies are decided automatically in the model. Usually it is set to “U” for upper limit of natural gas and NGL. However, in the case of crude oil, Bought is smaller than crude oil partner’s share, setting the upper limit of crude oil bought to the value.

6) Receivable

The receivable is an area to receive energy transferred from other sectors. LPG distribution and Power distribution sectors have receivable energies. When the energy balance table has differences with a (+) sign or other resources (+), these are set in the receivable area.

7) Final Demand

In the final demand area, a final demand aggregated with industry, commercial, transportation, residential and government demands is set in the upper limit. When it is set to have domestic demand be supplied, the upper limit and the lower limit of the final domestic demand have to be set. And the future data for the final domestic demand come from the energy demand forecasting model.

8) Export

In the export area, the upper limit and the lower limit of the energy export are set. The Export as a solution of LP model is displayed in the second line of the area. It is set to a condition that the energies can be exported when the energies are surplus to domestic demand. Then upper limit of the export has to be set to ‘U’, and the lower limit has to be set to the values for the future years.

9) Bunker Oil

In the bunker oil area, the upper limit and the lower limit of the bunker oil demand are set. The bunker oil demand as a solution of LP model is displayed in the second line of the area. Bunker oil is strictly supplied. Then the upper limit and the lower limit of bunker oil have to be set to the same value.

10) Payable

In the payable area, the upper limit and the lower limit of the payable energies are set. The payable energies as a solution of LP model is displayed in the second line of the area. The actual data of Transfer(-), Partner(-) and difference(-) in the energy balance table are also set in the area. But the future energies for the partners are internally calculated in the LP model.

11) Transformation

In the transformation area, the upper limit and the lower limit of the transformation energies are set. The limits do not give any constraints to the transformation in the LP model, and the transformation energies are internally calculated in the LP model. In the prepared model, the upper limit of Transformation is set to 'U', and the lower limit is set to 0.

12) Energy Own Use

In the energy own use area, the upper limit and the lower limit of the energy own use are set. The upper and lower limits do not give any constraints to the energy own use, and the energy own use are internally calculated in the LP model. In the prepared model, the upper limit of Energy own use is set to 'U', and the lower limit is set to 0 for energy sectors with energy own use.

13) Final-Stock

The final-stock usually does not have any value. Then the value of "U" (meaning infinite) is set in the area. When Stock change (-) in the energy balance table is described, the value should be put in the upper limit. And the final-stock in the final years has 0 in the upper limit because if the upper limit of the final-stock has a 0 value, the model sometimes has a final-stock as one of income items.

14) Price and Cost

Prices and cost data of Production cost, Import cost, Invoice cost, Sales price, Export price and Bunker oil price are connected to PIM sheet. And the data are revised in the PIM sheet.

(3) Energy Balance Estimation (EBT sheet)

1) Consumption

Domestic demand, Export, Bunker oil, Payable and Transformation are arranged as energy consumption items. The values of these items come from variables in the LPM sheet. The total consumption matches the total supply. If the total supply and the total consumption do not match, the LP model is not considered balanced.

Domestic demand, Export, Bunker oil and Payable in the consumption items may have values in the upper limit. Then, it is possible to analyze the values of Domestic demand, Export, Bunker oil and Payable, compared to the values in the upper limit.

A sufficient rate is defined by the following expressions. A sufficient rate of 100% means that the energy is supplied completely. Adversely, a sufficient rate of 0% means that the energy is not supplied at all even though the upper limit for the energy is set.

Domestic demand from LP model / Domestic demand in Upper limit * 100.
Export from LP model / Export in Upper limit *100
Bunkers from LP model / Bunker in Upper limit * 100
Payable from LP model / Payable in Upper limit * 100

Table 6.3.30 Consumption Items in "EBT" Sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Consumpti	Solution	Domestic demand	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	KTON	2,934.0	2,351.0	2,130.0	1,845.0	1,506.0	1,113.0	665.0	155.0
		Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable	KTON	13,280.4	15,621.2	16,000.0	15,962.7	15,700.7	15,401.1	15,062.9	14,681.7
		Transformation	KTON	25,641.8	27,180.8	27,970.0	28,199.0	28,145.1	28,088.6	28,029.3	27,967.5
		Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	KTON	41,856.2	45,153.0	46,100.0	46,006.7	45,351.8	44,602.7	43,757.2	42,804.2
	UpperLimit	Domestic demand	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	KTON	2,934.0	2,351.0	2,130.0	1,845.0	1,506.0	1,113.0	665.0	155.0
		Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable	KTON	U	U	U	U	U	U	U	U
	Sufficient ra	Domestic demand	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2) Supply

Initial-Stock, Production, Import, Bought, Receivable and Final-Stock are arranged as energy supply items. The final stock is considered as a consumption item. In the table, the final-stock is attributed as a supply item with a negative sign. By doing so, it is possible to easily analyze the difference between the initial-stock and the final-stock. The values in the solution lines of the supply come from variables in the "LPM" sheet.
The total supply agrees with the total consumption. If the total supply and the total consumption do not agree, the LP model is not considered balanced.

Production, Import, Bought and Receivable in the supply items may have upper limit values. Then, it is possible to analyze the values of Production, Import, Bought and Receivable, compared to the values in the upper limit.

A sufficient rate is defined by the following expressions. A sufficient rate of 100% means that the energy is supplied completely. Adversely, a sufficient rate of 0% means that the energy is not supplied at all even though the upper limit for the energy is set.

Production from LP model / Capacity in Upper limit * 100.
Production from LP model / Production in Upper limit *100
Import from LP model / Import in Upper limit * 100
Bought from LP model / Bought in Upper limit * 100
Receivable from LP model / Receivable in Upper limit * 100

Supply rate is defined by the following expressions. For example, a production supply rate of 100% means that all energy is supplied from production, and an import supply rate of

100% means that all energy is supplied from import.

Production rate = Production / Total supply * 100
Import rate = Import / Total supply * 100
Bought rate = Bought / Total supply *100
Receivable rate = Receivable / Total supply * 100

Table 6.2.31 Supply Items in “EBT” Sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production	KTON	35,796.2	39,053.0	40,000.0	39,906.7	39,251.8	38,502.7	37,657.2	36,704.2
		Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
		Receivable fm Differer	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	KTON	41,856.2	45,153.0	46,100.0	46,006.7	45,351.8	44,602.7	43,757.2	42,804.2
	UpperLimit	Capacity	KTON	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
		Production	KTON	39,516.0	39,496.0	40,034.0	40,532.0	40,999.0	41,441.0	41,865.0	42,276.0
		Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
		Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sufficient ra	Capacity	%	89.5	97.6	100.0	99.8	98.1	96.3	94.1	91.8
		Production	%	90.6	98.9	99.9	98.5	95.7	92.9	89.9	86.8
		Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply rate	Production rate	%	85.5	86.5	86.8	86.7	86.5	86.3	86.1	85.7
		Import rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought rate	%	14.5	13.5	13.2	13.3	13.5	13.7	13.9	14.3
		Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

3) Profitability

Income, Expense and Profit are arranged in Profitability. The values of income and expense come from the LPM sheet. The profitability is calculated as Income – Expense.

The profitability of price and cost items are displayed below. The items come from the LPM sheet. And profit per unit is calculated in this sheet.

ROI (return on investment) is an index that shows the profitability on the total investment. In the model, however, ROI is calculated as profit per unit / production cost * 100. Regarding energy issues, ROI is expected to be between 10% and 20% (The World Bank supports ROI with 15%).

Table 6.2.32 Profitability Items in "EBT" Sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Profitability	Profit	Income	millionLE	12,026.0	13,773.4	14,425.6	14,749.4	14,866.7	14,922.6	14,918.4	14,849.0
		Expense	millionLE	9,739.9	11,022.2	11,584.7	11,892.0	12,042.7	12,156.2	12,234.2	12,274.8
		Profit	millionLE	2,286.2	2,751.2	2,840.9	2,857.4	2,823.9	2,766.4	2,684.2	2,574.2
	Price & Unit	Sales price of Domest	LE/TON	374.3	417.6	430.1	442.3	454.3	466.2	478.1	490.3
		Sales price of Export	LE/TON	374.3	491.3	505.9	520.4	534.5	548.5	562.5	576.8
		Sales price of Bunkers	LE/TON	397.7	417.6	430.1	442.3	454.3	466.2	478.1	490.3
		Invoice cost	LE/TON	280.8	294.8	303.6	312.2	320.7	329.1	337.5	346.1
		Import cost	LE/TON	225.6	320.2	449.4	480.8	513.9	548.9	586.1	625.6
		Bought cost	LE/TON	252.3	264.9	272.8	280.6	288.2	295.8	303.3	311.0
		Production cost	LE/TON	229.4	240.9	248.0	255.1	262.0	268.9	275.7	282.7
		Profit per unit	LE/TON	54.6	60.9	61.6	62.1	62.3	62.0	61.3	60.1
		ROI	%	23.8	25.3	24.8	24.3	23.8	23.1	22.2	21.3

(4) Growth Rate of Energy Balance ("GRT" sheet)

1) Annual Growth Rate

The formula for the annual growth rate is defined as the following expression

IF Previous value Not = 0 or U

Then growth rate = (Current value / Previous value –1) *100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Gn=0,0, IF(EBT!Hn="U","U",(EBT!Hn/EBT!Gn-1)*100))

n: line number

2) Average Growth Rate in Actual Data (1994—1998)

The formula for the average growth rate in actual data is defined as the following expression

IF 1994 value Not = 0 or U

Then growth rate ={ (1998 value / 1994 value) ^(1/4)-1}*100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Gn=0,0,IF(EBT!Kn="U","U",((EBT!Kn/EBT!Gn)^(1/4)-1)*100))

n: line number

3) Average Growth Rate in Estimation Data (1998—2005)

The formula for the average growth rate in estimation data is defined as the following expression

IF 1998 value Not = 0 or U

Then growth rate ={ (2005 value / 1998 value) ^(1/7)-1}*100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Kn=0,0,IF(EBT!Rn="U","U",((EBT!Rn/EBT!Kn)^(1/7)-1)*100))

n: line number

4) Average Growth Rate in Future Data (2000—2005)

The formula for the average growth rate in future data is defined as the following expression

IF 2000 value Not = 0 or U

Then growth rate ={ (2005 value / 2000 value) ^(1/5)-1}*100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Mn=0,0,IF(EBT!Rn="U","U",((EBT!Rn/EBT!Mn)^(1/5)-1)*100))

n: line number

Table 6.2.33 Growth Rate Table of “EBT” Sheet

Energy Supply Planning Model (GRT list)					2002	2003	2004	2005	1998	2005	2005
ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	2001	2002	2003	2004	1994	1998	2000
Crude oil	Consumption	Solution	Domestic dema	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Export	KTON	-13.6	-19.0	-29.1	-51.6	-22.1	-22.7	-26.5
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	-1.5	-1.9	-2.4	0.3	0.9	-1.1
			Transformation	KTON	1.0	-0.1	-0.2	-0.2	4.2	0.6	0.3
			Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	0.0	-1.3	-1.7	-2.1	-0.4	-0.1	-1.0
		UpperLimit	Domestic dema	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Export	KTON	-13.6	-19.0	-29.1	-51.6	-22.1	-22.7	-26.5
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	U	U	U	U	U	U	U
		Sufficient rate	Domestic dema	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Export	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	0.0	-1.5	-1.9	-2.4	-1.2	-0.2	-1.1
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	0.0	0.0	0.0	0.0	5.1	0.1	0.0
			Receivable fm D	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	0.0	-1.3	-1.7	-2.1	-0.4	-0.1	-1.0
		UpperLimit	Capacity	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	0.7	0.7	0.6	0.6	-2.8	0.6	0.7
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	0.0	0.0	0.0	0.0	5.1	0.1	0.0
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient rate	Capacity	%	0.0	-1.5	-1.9	-2.4	-1.2	-0.2	-1.1
			Production	%	-0.7	-2.2	-2.5	-3.0	1.7	-0.8	-1.8
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	0.0	-0.2	-0.3	-0.3	-0.7	0.0	-0.2
			Import rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought rate	%	0.0	1.4	1.7	2.1	5.5	0.2	1.0
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	2.3	1.0	0.6	0.1	0.6	2.8	1.3
			Expense	millionLE	2.7	1.4	1.2	0.9	2.7	3.0	1.9
			Profit	millionLE	0.7	-1.0	-1.9	-3.3	-6.2	1.8	-0.9
		Price & Unit cost	Sales price of D	LE/TON	2.7	2.8	2.9	3.1	3.0	4.0	2.8
			Sales price of E	LE/TON	2.7	2.8	2.9	3.1	-1.3	6.5	2.8
			Sales price of B	LE/TON	2.7	2.8	2.9	3.1	3.0	3.1	2.8
			Invoice cost	LE/TON	2.7	2.8	2.9	3.1	3.0	3.1	2.8
			Import cost	LE/TON	6.8	6.8	6.8	6.8	-8.5	17.0	6.8
			Bought cost	LE/TON	2.7	2.8	2.9	3.1	3.0	3.1	2.8
			Production cost	LE/TON	2.7	2.8	2.9	3.1	3.0	3.1	2.8
			Profit per unit	LE/TON	0.7	0.4	-0.3	-1.2	-5.8	1.9	0.1

(5) Primary Energy Consumption (“PEC” sheet)

1) Indigenous Production

Indigenous productions in Egypt are Crude oil, Natural gas, NGL, FD-LPG, Hydro-power, Solar-Wind-Other power and Renewable energy. Other energies are not indigenous energies.

Table6.2.34 Indigenous Production in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Indigenous Productior	Coal	KTON	40.0	40.0	50.0	54.0	44.0	47.0	48.0	48.0
	Coke	KTON								
	Crude oil	KTON	35,796.2	39,053.0	40,000.0	39,906.7	39,251.8	38,502.7	37,657.2	36,704.2
	Natural gas	KTON	10,698.7	12,082.2	12,427.4	12,791.2	13,174.2	13,575.2	13,996.2	14,435.2
	NGL	KTON	1,506.4	1,701.2	1,749.8	1,801.0	1,854.9	1,911.4	1,970.7	2,032.5
	FD-LPG	KTON	1,005.6	1,135.7	1,168.1	1,202.3	1,238.3	1,276.0	1,315.6	1,356.8
	LPG distribution	KTON								
	LNG	KTON								
	Feedstock	KTON								
	RF-Gas	KTON								
	RF-LPG	KTON								
	Gasoline	KTON								
	Jet fuel	KTON								
	Kerosene	KTON								
	Diesel	KTON								
	Fuel oil	KTON								
	Naphtha	KTON								
	Lubricants & additives	KTON								
	Bitumen	KTON								
	Petroleum Coke	KTON								
	Non specified products	KTON								
	Power distribution	GWh								
	Power Hydro	GWh	15,000.0	15,282.0	15,550.0	15,804.0	16,047.0	16,278.0	16,500.0	16,713.0
	Power Gas combined	GWh								
	Power Coal steam	GWh								
	Power Gas turbine	GWh								
	Power Diesel engine	GWh								
	Power Fuel oil steam	GWh								
	Power Solar Wind Oth	GWh	25.0	67.0	445.0	914.0	1,289.0	2,048.0	3,407.0	3,500.0
	Renewable	KTON	99.0	99.0	100.0	282.0	283.0	283.0	284.0	285.0

2) Partner's Share

Crude oil, Natural gas and NGL have partner's shares. Then, these energies have to pay some energy to the partners. The following is the partners' share in the Crude oil, Natural gas and NGL sectors.

Table 6.2.35 Partner's Share in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Partners	Coal	KTON								
	Coke	KTON								
	Crude oil	KTON	13,280.4	15,621.2	16,000.0	15,962.7	15,700.7	15,401.1	15,062.9	14,681.7
	Natural gas	KTON	3,134.7	3,624.7	3,728.2	3,837.4	3,952.3	4,072.6	4,198.9	4,330.6
	NGL	KTON	468.5	544.4	559.9	576.3	593.6	611.6	630.6	650.4
	FD-LPG	KTON								
	LPG distribution	KTON								
	LNG	KTON								
	Feedstock	KTON								
	RF-Gas	KTON								
	RF-LPG	KTON								
	Gasoline	KTON								
	Jet fuel	KTON								
	Kerosene	KTON								
	Diesel	KTON								
	Fuel oil	KTON								
	Naphtha	KTON								
	Lubricants & additives	KTON								
	Bitumen	KTON								
	Petroleum Coke	KTON								
	Non specified products	KTON								
	Power distribution	GWh								
	Power Hydro	GWh								
	Power Gas combined	GWh								
	Power Coal steam	GWh								
	Power Gas turbine	GWh								
	Power Diesel engine	GWh								
	Power Fuel oil steam	GWh								
	Power Solar Wind Othe	GWh								
	Renewable	KTON								

3) Import

Some types of energy are imported from foreign countries. The imported energies are described in the following table.

Table 6.2.36 Import in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Import	Coal	KTON	1,574.1	1,913.5	1,950.0	1,996.7	2,061.6	2,119.2	2,183.0	2,252.0
	Coke	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Crude oil	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NGL	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	FD-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON	733.0	715.2	862.4	1,018.7	1,186.7	1,364.0	1,556.4	1,770.2
	LNG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON	144.6	154.0	200.4	278.1	372.1	463.1	551.1	639.1
	Jet fuel	KTON	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Kerosene	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Diesel	KTON	1,820.7	1,740.4	2,118.5	2,671.0	3,356.0	4,115.0	4,955.0	5,887.0
	Fuel oil	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Naphtha	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Lubricants & additives	KTON	90.0	85.8	89.5	97.0	108.0	118.0	128.0	139.0
	Bitumen	KTON	108.3	119.3	116.8	134.0	162.0	194.0	229.0	267.0
	Petroleum Coke	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON	246.1	372.7	379.7	389.0	400.0	411.0	422.0	433.0
	Power distribution	GWh	0.0	80.3	1,503.1	2,917.9	4,516.0	7,848.3	11,447.4	16,479.7
	Power Hydro	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas combined	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Renewable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4) Bought

Crude oil, Natural gas and NGL are bought from partners. All Natural gas from partners, all NGL from partners and part of crude oil paid to partners are bought back to the domestic market.

Table 6.2.37 Bought in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Bought	Coal	KTON								
	Coke	KTON								
	Crude oil	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
	Natural gas	KTON	3,134.7	3,624.7	3,728.2	3,837.4	3,952.3	4,072.6	4,198.9	4,330.6
	NGL	KTON	468.5	544.4	559.9	576.3	593.6	611.6	630.6	650.4
	FD-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON								
	LNG	KTON								
	Feedstock	KTON								
	RF-Gas	KTON								
	RF-LPG	KTON								
	Gasoline	KTON								
	Jet fuel	KTON								
	Kerosene	KTON								
	Diesel	KTON								
	Fuel oil	KTON								
	Naphtha	KTON								
	Lubricants & additives	KTON								
	Bitumen	KTON								
	Petroleum Coke	KTON								
	Non specified products	KTON								
	Power distribution	GWh								
	Power Hydro	GWh								
	Power Gas combined	GWh								
	Power Coal steam	GWh								
	Power Gas turbine	GWh								
	Power Diesel engine	GWh								
	Power Fuel oil steam	GWh								
	Power Solar Wind Othe	GWh								
	Renewable	KTON								

5) Export

Coke, crude oil, kerosene, naphtha are exported. In the table, fuel oil is exported, but it is the surplus fuel oil from the domestic market.

Table 6.2.38 Export in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Export	Coal	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coke	KTON	246.0	464.0	464.0	464.0	464.0	464.0	464.0	464.0
	Crude oil	KTON	2,934.0	2,351.0	2,130.0	1,845.0	1,506.0	1,113.0	665.0	155.0
	Natural gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NGL	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	FD-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LNG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Jet fuel	KTON	0.0	103.5	99.6	79.0	80.0	72.0	75.0	63.0
	Kerosene	KTON	0.0	147.0	286.0	420.0	548.0	571.0	640.0	703.0
	Diesel	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fuel oil	KTON	1,079.7	1,311.8	1,098.8	682.1	157.9	0.0	0.0	0.0
	Naphtha	KTON	2,849.4	2,960.4	3,046.3	3,075.0	3,075.0	3,075.0	3,075.0	3,075.0
	Lubricants & additives	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bitumen	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Petroleum Coke	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON	38.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power distribution	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Hydro	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas combined	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Renewable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6) Bunker Oil

Some portion of gasoline, Jet fuel and diesel are brought for Bunker oil use.

Table 6.2.39 Bunkers in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Bunkers	Coal	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coke	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Crude oil	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NGL	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	FD-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LNG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Jet fuel	KTON	412.0	336.0	357.0	378.0	370.0	371.0	362.0	368.0
	Kerosene	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Diesel	KTON	243.0	243.0	243.0	243.0	243.0	243.0	243.0	243.0
	Fuel oil	KTON	2,268.0	2,333.0	2,403.0	2,383.0	2,294.0	2,336.0	2,350.0	2,353.0
	Naphtha	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Lubricants & additives	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bitumen	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Petroleum Coke	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power distribution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Hydro	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas combined	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Renewable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7) Primary Energy Consumption

Primary energy consumption is defined as the following expression.

Indigenous production + Import + Bought – Partner – Export - Bunkers

In the following table, the energies with a plus sign are the net consumption in the domestic market and the energies with a minus sigh are the net export. The total from the energies after converting to toe is the primary energy consumption in Egypt.

Table 6.2.40 Primary Energy Consumption in "PEC" Sheet

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Primary Energy Consu	Coal	KTON	1,614.1	1,953.5	2,000.0	2,050.7	2,105.6	2,166.2	2,231.0	2,300.0
	Coke	KTON	-246.0	-464.0	-464.0	-464.0	-464.0	-464.0	-464.0	-464.0
	Crude oil	KTON	25,641.8	27,180.8	27,970.0	28,199.0	28,145.1	28,088.6	28,029.3	27,967.5
	Natural gas	KTON	10,698.7	12,082.2	12,427.4	12,791.2	13,174.2	13,575.2	13,996.2	14,435.2
	NGL	KTON	1,506.4	1,701.2	1,749.8	1,801.0	1,854.9	1,911.4	1,970.7	2,032.5
	FD-LPG	KTON	1,005.6	1,135.7	1,168.1	1,202.3	1,238.3	1,276.0	1,315.6	1,356.8
	LPG distribution	KTON	733.0	715.2	862.4	1,018.7	1,186.7	1,364.0	1,556.4	1,770.2
	LNG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON	144.5	153.9	200.3	278.0	372.0	463.0	551.0	639.0
	Jet fuel	KTON	-396.4	-439.5	-456.6	-457.0	-450.0	-443.0	-437.0	-431.0
	Kerosene	KTON	0.0	-147.0	-286.0	-420.0	-548.0	-571.0	-640.0	-703.0
	Diesel	KTON	1,577.7	1,497.4	1,875.5	2,428.0	3,113.0	3,872.0	4,712.0	5,644.0
	Fuel oil	KTON	-3,347.7	-3,644.8	-3,501.8	-3,065.1	-2,451.9	-2,336.0	-2,350.0	-2,353.0
	Naphtha	KTON	-2,849.4	-2,960.4	-3,046.3	-3,075.0	-3,075.0	-3,075.0	-3,075.0	-3,075.0
	Lubricants & additives	KTON	90.0	85.8	89.5	97.0	108.0	118.0	128.0	139.0
	Bitumen	KTON	108.3	119.3	116.8	134.0	162.0	194.0	229.0	267.0
	Petroleum Coke	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON	208.1	372.7	379.7	389.0	400.0	411.0	422.0	433.0
	Power distribution	GWh	0.0	80.3	1,503.1	2,917.9	4,516.0	7,848.3	11,447.4	16,479.7
	Power Hydro	GWh	15,000.0	15,282.0	15,550.0	15,804.0	16,047.0	16,278.0	16,500.0	16,713.0
	Power Gas combined	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh	25.0	67.0	445.0	914.0	1,289.0	2,048.0	3,407.0	3,500.0
	Renewable	KTON	99.0	99.0	100.0	282.0	283.0	283.0	284.0	285.0

8) Primary Energy by TOE unit

The following table is the primary energy after converting to TOE unit. The energies are totaled to primary energy consumption.

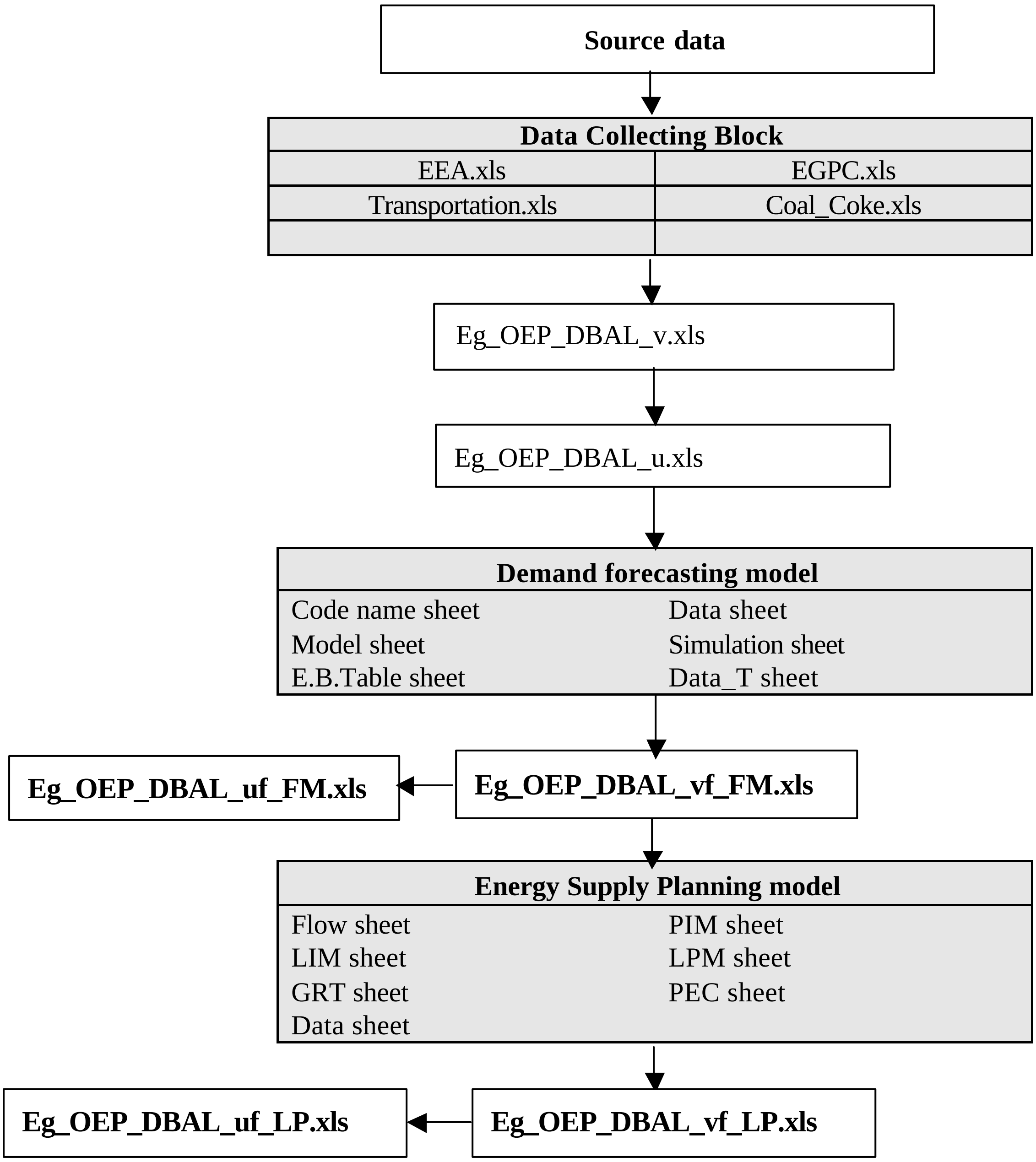
Table 6.2.41 Primary Energy Consumption by TOE Unit

ITEMS 1	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Primary Energy Consu	Coal	KTOE	1,287	1,414	1,438	1,466	1,496	1,530	1,567	1,609
	Coke	KTOE	-311	-385	-380	-376	-371	-367	-363	-359
	Crude oil	KTOE	27.041	27.309	27.830	28.058	28.004	27.948	27.889	27.828
	Natural gas	KTOE	11.603	13.427	13.806	14.211	14.636	15.082	15.549	16.036
	NGL	KTOE	1.622	1.877	1.930	1.986	2.046	2.108	2.174	2.242
	FD-LPG	KTOE	1,104	1,278	1,314	1,353	1,393	1,436	1,480	1,526
	LPG distribution	KTOE	756	799	968	1,134	1,299	1,460	1,619	1,779
	LNG	KTOE	0	0	0	0	0	0	0	0
	Feedstock	KTOE	0	0	0	0	0	0	0	0
	RF-Gas	KTOE	0	0	0	0	0	0	0	0
	RF-LPG	KTOE	0	0	0	0	0	0	0	0
	Gasoline	KTOE	34	147	221	307	410	511	608	705
	Jet fuel	KTOE	-479	-486	-496	-497	-489	-481	-474	-468
	Kerosene	KTOE	0	-283	-334	-445	-536	-620	-695	-763
	Diesel	KTOE	1,131	1,446	1,776	2,185	2,669	3,175	3,704	4,260
	Fuel oil	KTOE	-3,532	-4,024	-3,404	-2,979	-2,383	-2,271	-2,284	-2,287
	Naphtha	KTOE	-3.312	-3.295	-3.360	-3.392	-3.392	-3.392	-3.392	-3.392
	Lubricants & additives	KTOE	96	103	110	119	130	141	152	164
	Bitumen	KTOE	65	109	113	130	157	188	222	260
	Petroleum Coke	KTOE	0	0	0	0	0	0	0	0
	Non specified products	KTOE	378	375	371	370	370	370	370	370
	Power distribution	KTOE	-4.607	7	129	251	388	675	984	1.380
	Power Hydro	KTOE	1.290	1.314	1.337	1.359	1.380	1.400	1.419	1.437
	Power Gas combined	KTOE	0	0	0	0	0	0	0	0
	Power Coal steam	KTOE	0	0	0	0	0	0	0	0
	Power Gas turbine	KTOE	0	0	0	0	0	0	0	0
	Power Diesel engine	KTOE	0	0	0	0	0	0	0	0
	Power Fuel oil steam	KTOE	0	0	0	0	0	0	0	0
	Power Solar Wind Othe	KTOE	2	6	38	79	111	176	293	344
	Renewable	KTOE	19	20	20	56	57	57	57	57
	Total	KTOE	34.185.1	41.156.2	43.430.2	45.374.1	47.375.7	49.126.3	50.880.5	52.727.6
			41.173							

(6) Data Connection between ESPM and Energy Demand Forecasting Model

The energy economic model that includes all models built by OEP and JICA team is handled by the following data flow.

Figure 6.2.2 Relation between Database and "ESPM"



"nnnn.xls" means a book.
"mmm sheet" means a EXCEL sheet.

6.3 Simulation Results of Base Case

6.3.1 Preconditions

(1) Prices and Costs Estimation

The LP model uses some types of price and cost. Before the calculation begins, we have to set the energy prices and costs. The price and cost estimation sheet (PIM) is prepared for this purpose. The tool of the estimation is "Price net back method", in which primary energy and intermediate petroleum product prices are estimated by final demand energy prices. For the estimation, several exogenous variables, such as Crude oil Price ($/bbl), Coal Price ($/ton), WPI (1996=100) and Exchange rate (LE/$), are used. The exogenous variables are estimated in the macro economic model. The following is a typical price and cost estimation in PIM sheet of ESPM.

Table 6.3.1 Exogenous Variables for Price and Cost Estimation

G	H	I	J	1998	1999	2000	2001	2002	2003	2004	2005
Exogenous	Trends	Crude oil Price(Dubai spo	$/bbl	12.8	18.0	25.0	26.5	28.1	29.8	31.6	33.5
		Coal Price(Australlia FOB	$/ton	30.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
		WPI (1996=100)	1996=100	106.1	111.9	118.1	124.4	130.8	137.3	144.0	151.1
		Exchange rate	LE/$	3.4	3.4	3.5	3.5	3.5	3.5	3.6	3.6
	Growth r	Crude oil Price	%	-31.8	40.5	38.9	6.0	6.0	6.0	6.0	6.0
		Coal Price	%	-13.0	-16.7	0.0	0.0	0.0	0.0	0.0	0.0
		WPI	%	5.0	5.4	5.5	5.4	5.1	5.0	4.9	4.9
	International petroleum price / Domestic pet			1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

Table 6.3.2 Price and Cost Estimation of Crude Oil and Natural Gas

G	H	I	J	1998	1999	2000	2001	2002	2003	2004	2005
Crude oil PC	Cost	Partner cost	LE/TON	62.1	68.7	70.6	72.5	74.4	76.2	78.1	80.0
		Plant cost	LE/TON	167.3	171.8	176.6	181.3	186.0	190.6	195.3	200.0
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	229.4	240.5	247.2	253.8	260.3	266.8	273.4	280.1
		Import cost	LE/TON	225.6	320.0	448.7	479.7	512.5	547.2	584.1	623.3
		Bought cost	LE/TON	252.3	264.6	271.9	279.2	286.4	293.5	300.7	308.1
		Average cost	LE/TON	234.0	245.3	252.1	258.9	265.5	272.2	278.9	285.7
	Prices	ROI for Invoice	%	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	280.8	294.4	302.6	310.7	318.7	326.6	334.6	342.8
		ROI for Domestics	%	60.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	374.3	417.1	428.6	440.1	451.4	462.7	474.0	485.6
		ROI for Export	%	60.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Sales price of Export	LE/TON	374.3	490.7	504.3	517.8	531.1	544.3	557.7	571.3
		ROI for Bunkers	%	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
		Sales price of Bunkers	LE/TON	397.7	417.1	428.6	440.1	451.4	462.7	474.0	485.6
Natural gas PC	Cost	Partner cost	LE/TON	32.7	34.4	35.3	36.3	37.2	38.1	39.1	40.0
		Plant cost	LE/TON	111.5	114.5	117.7	120.9	124.0	127.1	130.2	133.4
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	144.2	148.9	153.0	157.1	161.2	165.2	169.2	173.4
		Import cost	LE/TON	158.6	163.8	168.3	172.8	177.3	181.7	186.2	190.7
		Bought cost	LE/TON	158.6	163.8	168.3	172.8	177.3	181.7	186.2	190.7
		Average cost	LE/TON	147.1	151.9	156.1	160.3	164.4	168.5	172.6	176.8
	Prices	ROI for Invoice	%	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	169.2	174.7	179.5	184.3	189.0	193.8	198.5	203.4
		ROI for Domestics	%	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	169.2	174.7	179.5	184.3	189.0	193.8	198.5	203.4
		ROI for Export	%	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
		Sales price of Export	LE/TON	169.2	174.7	179.5	184.3	189.0	193.8	198.5	203.4
		ROI for Bunkers	%	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
		Sales price of Bunkers	LE/TON	169.2	174.7	179.5	184.3	189.0	193.8	198.5	203.4
		Slaes price of Domestic market		175.0	186.1	198.1	210.0	221.9	234.2	246.8	260.0

Table 6.3.3 Price and Cost Estimation of LPG and Gasoline

G	H	I	J	1998	1999	2000	2001	2002	2003	2004	2005
LPG distribut PC	Cost	Variable cost	LE/TON	198.6	205.0	210.7	216.4	221.9	227.5	233.0	238.7
		Plant cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	198.6	205.0	210.7	216.4	221.9	227.5	233.0	238.7
		Import cost	LE/TON	218.4	225.5	231.8	238.0	244.1	250.2	256.3	262.6
		Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average cost	LE/TON	198.6	205.0	210.7	216.4	221.9	227.5	233.0	238.7
	Prices	ROI for Invoice	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	208.5	215.3	221.3	227.2	233.0	238.8	244.7	250.7
		ROI for Domestics	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	208.5	215.3	221.3	227.2	233.0	238.8	244.7	250.7
		ROI for Export	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Export	LE/TON	208.5	215.3	221.3	227.2	233.0	238.8	244.7	250.7
		ROI for Bunkers	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Bunkers	LE/TON	208.5	215.3	221.3	227.2	233.0	238.8	244.7	250.7
		Slaes price of Domestic market		200.0	212.7	226.4	240.0	253.6	267.6	282.1	297.2
Gasoline PC	Cost	Variable cost	LE/TON	1,115.7	1,168.5	1,200.8	1,233.0	1,264.7	1,296.2	1,328.0	1,360.5
		Plant cost	LE/TON	227.2	233.3	239.8	246.2	252.6	258.9	265.2	271.7
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	1,343.0	1,401.8	1,440.6	1,479.3	1,517.2	1,555.1	1,593.2	1,632.2
		Import cost	LE/TON	1,477.2	1,542.0	1,584.7	1,627.2	1,668.9	1,710.6	1,752.6	1,795.4
		Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average cost	LE/TON	1,343.0	1,401.8	1,440.6	1,479.3	1,517.2	1,555.1	1,593.2	1,632.2
	Prices	ROI for Invoice	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	1,477.2	1,542.0	1,584.7	1,627.2	1,668.9	1,710.6	1,752.6	1,795.4
		ROI for Domestics	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	1,477.2	1,542.0	1,584.7	1,627.2	1,668.9	1,710.6	1,752.6	1,795.4
		ROI for Export	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Export	LE/TON	1,477.2	1,542.0	1,584.7	1,627.2	1,668.9	1,710.6	1,752.6	1,795.4
		ROI for Bunkers	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Bunkers	LE/TON	1,477.2	1,542.0	1,584.7	1,627.2	1,668.9	1,710.6	1,752.6	1,795.4
		Slaes price of Domestic market		1,305.0	1,387.9	1,477.3	1,565.8	1,654.9	1,746.1	1,840.5	1,939.1

Table 6.3.4 Price and Cost Estimation of Kerosene and Diesel

G	H	I	J	1998	1999	2000	2001	2002	2003	2004	2005
Kerosene PC	Cost	Variable cost	LE/TON	278.9	292.1	300.2	308.3	316.2	324.1	332.0	340.1
		Plant cost	LE/TON	227.2	233.3	239.8	246.2	252.6	258.9	265.2	271.7
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	506.2	525.5	540.0	554.5	568.7	582.9	597.2	611.8
		Import cost	LE/TON	556.8	578.0	594.0	609.9	625.6	641.2	656.9	673.0
		Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average cost	LE/TON	506.2	525.5	540.0	554.5	568.7	582.9	597.2	611.8
	Prices	ROI for Invoice	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	531.5	551.7	567.0	582.2	597.2	612.0	627.1	642.4
		ROI for Domestics	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	531.5	551.7	567.0	582.2	597.2	612.0	627.1	642.4
		ROI for Export	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Export	LE/TON	531.5	551.7	567.0	582.2	597.2	612.0	627.1	642.4
		ROI for Bunkers	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Bunkers	LE/TON	531.5	551.7	567.0	582.2	597.2	612.0	627.1	642.4
		Slaes price of Domestic market		504.0	536.0	570.5	604.7	639.1	674.4	710.8	748.9
Diesel PC	Cost	Variable cost	LE/TON	283.4	296.8	305.0	313.2	321.2	329.2	337.3	345.6
		Plant cost	LE/TON	227.2	233.3	239.8	246.2	252.6	258.9	265.2	271.7
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	510.6	530.1	544.8	559.4	573.8	588.1	602.5	617.2
		Import cost	LE/TON	561.7	583.1	599.3	615.4	631.2	646.9	662.8	679.0
		Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average cost	LE/TON	510.6	530.1	544.8	559.4	573.8	588.1	602.5	617.2
	Prices	ROI for Invoice	%	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	255.3	265.1	272.4	279.7	286.9	294.0	301.3	308.6
		ROI for Domestics	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	561.7	583.1	599.3	615.4	631.2	646.9	662.8	679.0
		ROI for Export	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Export	LE/TON	561.7	583.1	599.3	615.4	631.2	646.9	662.8	679.0
		ROI for Bunkers	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Bunkers	LE/TON	561.7	583.1	599.3	615.4	631.2	646.9	662.8	679.0
		Slaes price of Domestic market		504.0	536.0	570.5	604.7	639.1	674.4	710.8	748.9

Table 6.3.5 Price and Cost Estimation of Fuel Oil and Power

G	H	I	J	1998	1999	2000	2001	2002	2003	2004	2005
Fuel oil PC	Cost	Variable cost	LE/TON	142.1	148.8	153.0	157.1	161.1	165.1	169.2	173.3
		Plant cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/TON	142.1	148.8	153.0	157.1	161.1	165.1	169.2	173.3
		Import cost	LE/TON	156.3	163.7	168.3	172.8	177.2	181.6	186.1	190.6
		Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average cost	LE/TON	142.1	148.8	153.0	157.1	161.1	165.1	169.2	173.3
	Prices	ROI for Invoice	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON	156.3	163.7	168.3	172.8	177.2	181.6	186.1	190.6
		ROI for Domestics	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON	156.3	163.7	168.3	172.8	177.2	181.6	186.1	190.6
		ROI for Export	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Export	LE/TON	156.3	163.7	168.3	172.8	177.2	181.6	186.1	190.6
		ROI for Bunkers	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Bunkers	LE/TON	156.3	163.7	168.3	172.8	177.2	181.6	186.1	190.6
		Slaes price of Domestic market		182.0	193.6	206.0	218.4	230.8	243.5	256.7	270.4
Power distrib PC	Cost	Variable cost	LE/MWh	150.2	152.5	156.7	160.9	165.0	169.1	173.3	177.5
		Plant cost	LE/MWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Other cost	LE/MWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production cost	LE/MWh	150.2	152.5	156.7	160.9	165.0	169.1	173.3	177.5
		Import cost	LE/MWh	165.2	167.7	172.3	177.0	181.5	186.0	190.6	195.3
		Bought cost	LE/MWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average cost	LE/MWh	150.2	152.5	156.7	160.9	165.0	169.1	173.3	177.5
	Prices	ROI for Invoice	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Invoice	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/MWh	157.7	160.1	164.5	168.9	173.3	177.6	181.9	186.4
		ROI for Domestics	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Domesti	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/MWh	157.7	160.1	164.5	168.9	173.3	177.6	181.9	186.4
		ROI for Export	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Export	LE/MWh	157.7	160.1	164.5	168.9	173.3	177.6	181.9	186.4
		ROI for Bunkers	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Bunkers	LE/MWh	157.7	160.1	164.5	168.9	173.3	177.6	181.9	186.4
		Slaes price of Domestic market (fo		132.7	141.1	150.2	159.2	168.3	177.6	187.2	197.2

(2) Partner's Shares

Partner shares increase year by year. In the base case, the partner shares of crude oil, natural gas and NGL are set as the same shares from 1999.

Table 6.3.6 Partner's Shares of the Base Case

ITEMS 2	SECTORS	1998	1999	2000	2001	2002	2003	2004	2005
Shares	Crude oil	0.3710	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
	Natural Gas	0.2930	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
	NGL	0.3110	0.3200	0.3200	0.3200	0.3200	0.3200	0.3200	0.3200
	FD-LPG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

(3) Efficiencies and Yields

In the base case, the following efficiencies and yields are used in the model. The yields in refinery are crude oil yields and NGL yields.

Table 6.3.7 Efficiencies and Yields of the Base Case

Efficiencies	Coke	Coke / Coal	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100
	NGL	NGL / NG	0.1408	0.1408	0.1408	0.1408	0.1408	0.1408	0.1408	0.1408
	FD-LPG	FD-LPG / NG	0.0940	0.0940	0.0940	0.0940	0.0940	0.0940	0.0940	0.0940
	LNG	LNG/NG	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900
Yields	Refinery from crud	Refinery Gas	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Crude oil	RF-LPG	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
		Gasoline	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759
		Jet fuel	0.0300	0.0300	0.0300	0.0300	0.0300	0.0300	0.0300	0.0300
		Kerosene	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
		Diesel	0.2140	0.2140	0.2140	0.2140	0.2140	0.2140	0.2140	0.2140
		Fuel oil	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620
		Naphtha	0.1025	0.1025	0.1025	0.1025	0.1025	0.1025	0.1025	0.1025
		Lubricants & additives	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090
		Bitumen	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280
		Petroleum Coke	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
		Non specified products	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
		Crude oil	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884
Yields	Refinery from NGL	Refinery Gas	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	NGL	RF-LPG	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
		Gasoline	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759
		Jet fuel	0.0300	0.0300	0.0300	0.0300	0.0300	0.0300	0.0300	0.0300
		Kerosene	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
		Diesel	0.2140	0.2140	0.2140	0.2140	0.2140	0.2140	0.2140	0.2140
		Fuel oil	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620
		Naphtha	0.1025	0.1025	0.1025	0.1025	0.1025	0.1025	0.1025	0.1025
		Lubricants & additives	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090	0.0090
		Bitumen	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280
		Petroleum Coke	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
		Non specified products	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
		NGL	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884	-0.9884
Yields	Refinery	Diesel to Refinery feed	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
	Own use	Fuel oil to Refnery feed	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190
		Refinery Gas to Refinery Gas	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		Lubricants & additives to Lub	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260
		Natural Gas to Refinery feed	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098

(4) Capacity

The current capacity data and incremental capacity information in future are not collected. We set the estimated capacity for past years and set the latest capacity for the future.

Table 6.3.8 Plant Capacities of the Base Case

ITEMS 1	SECTORS	1998	1999	2000	2001	2002	2003	2004	2005
Coke	Capacity of production	2,000.0	2,000.0	2,000.0	2,000.0	2,000.0	2,000.0	2,000.0	2,000.0
		68.2	74.9	76.2	77.7	79.3	81.1	83.1	85.2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude oil	Capacity of production	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
		95.6	98.7	100.0	99.8	98.1	96.3	94.1	91.8
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas	Capacity of production	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0
		52.2	60.4	62.1	64.0	65.9	67.9	70.0	72.2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feedstock for r	Capacity of production	30,000.0	30,000.0	30,000.0	30,000.0	30,000.0	30,000.0	30,000.0	30,000.0
		95.5	97.2	99.1	100.0	100.0	100.0	100.0	100.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas combined	Capacity of production	26,926.7	27,000.0	27,000.0	27,000.0	27,000.0	27,000.0	27,000.0	27,000.0
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas turbine po	Capacity of production	6,265.3	7,000.0	7,000.0	7,000.0	7,000.0	7,000.0	7,000.0	7,000.0
		48.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel engine r	Capacity of production	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9
Fuel oil steam	Capacity of production	17,809.7	19,590.7	21,549.7	23,704.7	26,075.2	28,682.7	31,551.0	34,706.1
	1.1	100.0	100.0	100.0	100.0	100.0	92.1	83.0	75.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.3.2 Energy Balance of Base Case

After entering the above data, ESPM can compute the supply/demand balance. The calculation results are described on EBT sheet. And the following items are the checkpoints for this model.

Checkpoint 1 Domestic demand can be supplied or not. (Full supply or Partial supply)

Checkpoint 2 Does production capacity allowance exist or not.

Checkpoint 3 Domestic demand is supplied by production and/or import.

Checkpoint 4 Profit value increases or not.

(1) Contents of Base Case

1) Price and Demand Data

The domestic energy market price and WPI trend are forecast in the macro economic model. The energy demand is forecast by the energy demand-forecasting model. The forecast value is input to the ESPM (Energy Supply Planning Model: LP model). The ESPM uses other data such as production capacity, efficiencies and yields, partner's shares, etc. These data also are input by referencing energy balance table.

2) Preconditions

The base case has several preconditions under which all domestic energy demand must be supplied preferentially. When energy supply is in shortage, Egypt can import the energy; when energy supply is in surplus, Egypt can export the energy. The following are other preconditions of the base case.

Table 6.3.9 Preconditions of the Base Case

Items	Contents
Price and Cost	Energy prices and cost are forecast by net back method based on energy market prices
Crude oil production	40million ton flat (current capacity is extended)
Crude oil Bought	6.1 million ton flat (current bought is extended)
Natural gas production	20million ton flat (current bought is extended)
Natural gas Bought	Partners' natural gas all return
Refinery capacity	30million ton flat of crude oil processed
Petroleum products import	If petroleum product supply is in shortage, the energy sector can import enough energy to meet the demand
Petroleum products Export	If petroleum product supply is in surplus, the energy sector can export enough energy to meet the balance
Power distribution	The current incremental power plan is set. If the generated power is in shortage for the power demand, the power distribution sector can import enough power to meet the demand.
Hydro Power	Hydropower is operated preferentially.
Diesel engine	Basically, diesel engine is an alternative power generator. But, in the model, the diesel generator is operated forcedly.

Gas combined generator	Gas-combined is the most effective generator. The generator has an assumption to consume 60% of natural gas transformation to power. Another is consumed in Gas-turbine generator.
Fuel oil steam generator	In fact, several kinds of energy are consumed in fuel oil steam generator. But the generator consumes only fuel oil in the model.

(2) Supply Balance Forecast of Crude Oil

+ Under the current capacity of crude oil sector, there is no big problem with the crude oil supply. But in 2005, refinery plants are in full operation and the plants have no allowance.
+ The intentional export of crude oil decreases slightly, and the export can be supplied in the targeted years.
+ Profits in the crude oil sector increase nominally in order for the energy price to go up due to inflation.

Table 6.3.10 Energy Balance of Crude Oil

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Crude oil	Consumpti	Solution	Domestic demand	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Export	KTON	2,934.0	2,353.7	1,981.8	1,532.6	993.1	348.0	0.0	0.0
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	13,989.5	15,802.7	15,941.0	16,000.0	16,000.0	16,000.0	16,000.0	16,000.0
			Transformation	KTON	26,844.0	27,450.3	28,029.7	28,567.4	29,106.9	29,752.0	30,100.0	30,100.0
			Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	43,767.5	45,606.6	45,952.5	46,100.0	46,100.0	46,100.0	46,100.0	46,100.0
		UpperLimit	Domestic demand	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Export	KTON	2,934.0	2,353.7	1,981.8	1,532.6	993.1	348.0	0.0	0.0
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	U	U	U	U	U	U	U	U
		Sufficient ra	Domestic demand	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Export	%	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0
			Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	37,707.5	39,506.6	39,852.5	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
			Receivable fm Differer	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	43,767.5	45,606.6	45,952.5	46,100.0	46,100.0	46,100.0	46,100.0	46,100.0
		UpperLimit	Capacity	KTON	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
			Production	KTON	39,516.0	39,506.6	39,852.5	40,165.5	40,454.2	40,725.0	40,982.8	41,231.2
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Capacity	%	94.3	98.8	99.6	100.0	100.0	100.0	100.0	100.0
			Production	%	95.4	100.0	100.0	99.6	98.9	98.2	97.6	97.0
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	86.2	86.6	86.7	86.8	86.8	86.8	86.8	86.8
			Import rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought rate	%	13.8	13.4	13.3	13.2	13.2	13.2	13.2	13.2
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	12,488.4	14,187.8	14,998.3	15,753.3	16,475.5	17,225.3	18,126.4	19,229.2
			Expense	millionLE	10,118.1	11,355.7	12,069.2	12,757.9	13,445.4	14,187.7	15,005.1	15,918.0
			Profit	millionLE	2,370.3	2,832.1	2,929.1	2,995.4	3,030.1	3,037.5	3,121.3	3,311.2
		Price & Unit	Sales price of Domest	LE/TON	372.1	426.1	449.5	473.6	499.1	526.7	557.0	590.9
			Sales price of Export	LE/TON	372.1	501.2	528.8	557.2	587.2	619.6	655.3	695.2
			Sales price of Bunkers	LE/TON	395.4	426.1	449.5	473.6	499.1	526.7	557.0	590.9
			Invoice cost	LE/TON	279.1	300.7	317.3	334.3	352.3	371.8	393.2	417.1
			Import cost	LE/TON	212.2	339.1	459.0	490.0	523.1	558.3	596.0	636.3
			Bought cost	LE/TON	250.8	270.3	285.1	300.4	316.6	334.1	353.4	374.9
			Production cost	LE/TON	228.0	245.7	259.2	273.1	287.8	303.7	321.2	340.8
			Profit per unit	LE/TON	54.2	62.1	63.7	65.0	65.7	65.9	67.7	71.8
			ROI	%	23.8	25.3	24.6	23.8	22.8	21.7	21.1	21.1

(3) Supply Balance Forecast of Natural Gas

+ Under the current supply availability of natural gas, the operation rate is around 61% in 2005. This means that the natural gas sector can supply more natural gas to the down flow sectors.
+ If Egypt can build other gas combined power generators, under the current situation, the natural gas sector would have the availability with which natural gas can be supplied to other gas combined power generators.

Table 6.3.11 Energy Balance of Natural Gas

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Natural ga	Consumpti	Solution	Domestic demand	KTON	3,309.0	3,487.9	3,692.9	3,922.3	4,175.3	4,453.3	4,759.3	5,097.6
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	3,068.3	3,280.5	3,343.3	3,413.2	3,490.0	3,573.5	3,665.2	3,766.7
			Transformation	KTON	6,882.5	7,164.2	7,164.2	7,164.2	7,164.2	7,164.2	7,164.2	7,164.2
			Own use	KTON	280.5	283.0	287.4	290.9	294.0	294.0	294.0	294.0
			Total	KTON	13,540.3	14,215.6	14,487.8	14,790.6	15,123.5	15,485.0	15,882.7	16,322.4
		UpperLimit	Domestic demand	KTON	3,309.0	3,487.9	3,692.9	3,922.3	4,175.3	4,453.3	4,759.3	5,097.6
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable to Partners	KTON	U	U	U	U	U	U	U	U
		Sufficient ra	Domestic demand	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Export	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	10,472.0	10,935.0	11,144.5	11,377.4	11,633.5	11,911.5	12,217.5	12,555.7
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	3,068.3	3,280.5	3,343.3	3,413.2	3,490.0	3,573.5	3,665.2	3,766.7
			Receivable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	13,540.3	14,215.6	14,487.8	14,790.6	15,123.5	15,485.0	15,882.7	16,322.5
		UpperLimit	Capacity	KTON	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0	20,000.0
			Production	KTON	11,872.0	12,894.2	13,898.2	14,989.7	16,182.7	17,491.1	18,932.9	20,532.1
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	U	U	U	U	U	U	U	U
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Capacity	%	52.4	54.7	55.7	56.9	58.2	59.6	61.1	62.8
			Production	%	88.2	84.8	80.2	75.9	71.9	68.1	64.5	61.2
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	77.3	76.9	76.9	76.9	76.9	76.9	76.9	76.9
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	22.7	23.1	23.1	23.1	23.1	23.1	23.1	23.1
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	2,290.6	2,484.7	2,602.1	2,728.3	2,865.6	3,016.0	3,183.4	3,371.4
			Expense	millionLE	1,997.0	2,167.1	2,269.5	2,379.6	2,499.3	2,630.5	2,776.5	2,940.5
			Profit	millionLE	293.6	317.6	332.6	348.7	366.3	385.5	406.9	430.9
		Price & Unit	Sales price of Domest	LE/TON	169.2	174.8	179.6	184.5	189.5	194.8	200.4	206.5
			Sales price of Export	LE/TON	169.2	174.8	179.6	184.5	189.5	194.8	200.4	206.5
			Sales price of Bunkers	LE/TON	169.2	174.8	179.6	184.5	189.5	194.8	200.4	206.5
			Invoice cost	LE/TON	169.2	174.8	179.6	184.5	189.5	194.8	200.4	206.5
			Import	LE/TON	158.6	163.9	168.4	173.0	177.7	182.6	188.0	193.7
			Bought	LE/TON	158.6	163.9	168.4	173.0	177.7	182.6	188.0	193.7
			Production cost	LE/TON	144.2	149.0	153.1	157.3	161.5	166.0	170.9	176.1
			Profit per unit	LE/TON	21.7	22.3	23.0	23.6	24.2	24.9	25.6	26.4
			ROI	%	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

(4) Supply Balance Forecast of LPG

+ LPG supply is in shortage. Egypt is required to make a plan to produce additional LPG if possible.
+ When an energy sector imports energy, the profits shrink or turn negative because import costs are 10% higher than the domestic market price.

Table 6.3.12 Energy Balance of LPG

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
LPG distri	Consumpti	Solution	Domestic demand	KTON	2,112.0	2,312.5	2,502.8	2,688.4	2,873.5	3,061.7	3,256.7	3,462.6
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Transformation	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	2,112.0	2,312.5	2,502.8	2,688.4	2,873.5	3,061.7	3,256.7	3,462.6
		UpperLimit	Domestic demand	KTON	2,112.0	2,312.5	2,502.8	2,688.4	2,873.5	3,061.7	3,256.7	3,462.6
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Domestic demand	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Export	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	KTON	672.3	596.5	698.6	789.1	871.3	947.1	1,023.8	1,105.0
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable fm FD-LP(	KTON	1,439.7	1,716.0	1,804.2	1,899.3	2,002.2	2,114.6	2,232.9	2,357.6
			Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	2,112.0	2,312.5	2,502.8	2,688.4	2,873.5	3,061.7	3,256.7	3,462.6
		UpperLimit	Capacity	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	KTON	U	U	U	U	U	U	U	U
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	KTON	1,440.0	U	U	U	U	U	U	U
		Sufficient ra	Capacity	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	%	31.8	25.8	27.9	29.4	30.3	30.9	31.4	31.9
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable rate	%	68.2	74.2	72.1	70.6	69.7	69.1	68.6	68.1
	Profitability	Profit	Income	millionLE	423.0	491.5	561.2	665.4	783.7	881.1	991.2	1,118.0
			Expense	millionLE	415.7	480.2	549.4	622.7	702.1	789.9	889.0	1,003.2
			Profit	millionLE	7.3	11.3	11.8	42.7	81.6	91.2	102.2	114.8
		Price & Unit	Sales price of Domest	LE/TON	200.3	212.6	224.2	247.5	272.7	287.8	304.4	322.9
			Sales price of Export	LE/TON	200.3	212.6	224.2	236.3	249.0	262.8	277.9	294.8
			Sales price of Bunkers	LE/TON	200.3	212.6	224.2	236.3	249.0	262.8	277.9	294.8
			Invoice cost	LE/TON	200.3	212.6	224.2	236.3	249.0	262.8	277.9	294.8
			Import cost	LE/TON	209.8	222.7	234.9	247.5	260.9	275.3	291.1	308.8
			Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production cost	LE/TON	190.7	202.4	213.6	225.0	237.2	250.2	264.7	280.8
			Profit per unit	LE/TON	3.5	4.9	4.7	15.9	28.4	29.8	31.4	33.2
			ROI	%	1.8	2.4	2.2	7.1	12.0	11.9	11.9	11.8

(5) Supply Balance Forecast of Gasoline

+ Gasoline supply is in shortage in 1999, and gasoline supply continues to be in shortage in the target years.
+ Import rate (import / total supply) is 4.6% in 1999 and will be 13.1% in 2005.
+ Gasoline ROI is stable from 1999 to 2005. The range of its ROI is between 9% and 14%. As gasoline is added up to a half of fuel oil variable costs, the ROI of gasoline is calculated as less than 15%. If gasoline is not added up to a part of fuel oil costs, it is assumed that the ROI of gasoline is greater than 15%.

Table 6.3.13 Energy Balance of Gasoline

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Gasoline	Consumptio	Solution	Domestic demand	KTON	2,205.0	2,346.0	2,456.0	2,555.0	2,649.0	2,740.0	2,828.0	2,916.0
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Transformation	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	2,205.1	2,346.0	2,456.0	2,555.0	2,649.0	2,740.0	2,828.0	2,916.0
		UpperLimit	Domestic demand	KTON	2,205.0	2,346.0	2,456.0	2,555.0	2,649.0	2,740.0	2,828.0	2,916.0
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Domestic demand	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Export	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	2,149.7	2,238.9	2,294.8	2,349.0	2,404.5	2,469.2	2,513.7	2,534.5
			Import	KTON	55.4	107.1	161.2	206.0	244.5	270.8	314.3	381.5
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	2,205.1	2,346.0	2,456.0	2,555.0	2,649.0	2,740.0	2,828.0	2,916.0
		UpperLimit	Capacity	KTON	U	U	U	U	U	U	U	U
			Production	KTON	U	U	U	U	U	U	U	U
			Import	KTON	U	U	U	U	U	U	U	U
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Capacity	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	97.5	95.4	93.4	91.9	90.8	90.1	88.9	86.9
			Import rate	%	2.5	4.6	6.6	8.1	9.2	9.9	11.1	13.1
			Bought rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	2,896.4	3,303.9	3,648.9	3,999.9	4,569.2	4,987.1	5,443.8	5,954.7
			Expense	millionLE	2,639.7	3,017.3	3,338.9	3,665.6	4,009.9	4,379.5	4,786.3	5,245.8
			Profit	millionLE	256.7	286.6	309.9	334.3	559.3	607.6	657.4	709.0
		Price & Uni	Sales price of Domes	LE/TON	1,313.5	1,408.3	1,485.7	1,565.5	1,724.9	1,820.1	1,925.0	2,042.1
			Sales price of Export	LE/TON	1,313.5	1,408.3	1,485.7	1,565.5	1,649.9	1,741.0	1,841.3	1,953.3
			Sales price of Bunkers	LE/TON	1,313.5	1,408.3	1,485.7	1,565.5	1,649.9	1,741.0	1,841.3	1,953.3
			Invoice cost	LE/TON	1,313.5	1,408.3	1,485.7	1,565.5	1,649.9	1,741.0	1,841.3	1,953.3
			Import cost	LE/TON	1,313.5	1,408.3	1,485.7	1,565.5	1,649.9	1,741.0	1,841.3	1,953.3
			Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production cost	LE/TON	1,194.1	1,280.3	1,350.6	1,423.2	1,499.9	1,582.7	1,673.9	1,775.7
			Profit per unit	LE/TON	116.4	122.2	126.2	130.8	211.1	221.8	232.5	243.1
			ROI	%	9.7	9.5	9.3	9.2	14.1	14.0	13.9	13.7

(6) Supply Balance Forecast of Kerosene

+ Kerosene has the surplus because the domestic demand goes down in future. In the base case, export of kerosene is assumed.
+ For energy supply planning, the consumption of surplus kerosene in the domestic market becomes a problem.

Table 6.3.14 Energy Balance of Kerosene

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Kerosene	Consumpt	Solution	Domestic demand	KTON	1,074.0	977.6	881.7	791.0	707.4	631.5	563.5	503.0
			Export	KTON	0.0	301.1	365.7	493.4	615.6	735.3	839.4	926.6
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Transformation	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	1,074.0	1,278.7	1,247.5	1,284.4	1,323.0	1,366.9	1,402.9	1,429.6
		UpperLimit	Domestic demand	KTON	1,074.0	977.6	881.7	791.0	707.4	631.5	563.5	503.0
			Export	KTON	0.0	U	U	U	U	U	U	U
			Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Domestic demand	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Export	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	8.9	67.9	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	1,133.0	1,210.8	1,247.5	1,284.4	1,323.0	1,366.9	1,402.9	1,429.6
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	-67.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	1,074.0	1,278.7	1,247.5	1,284.4	1,323.0	1,366.9	1,402.9	1,429.6
		UpperLimit	Capacity	KTON	U	U	U	U	U	U	U	U
			Production	KTON	U	U	U	U	U	U	U	U
			Import	KTON	U	U	U	U	U	U	U	U
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Capacity	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	105.5	94.7	100.0	100.0	100.0	100.0	100.0	100.0
			Import rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	602.4	721.6	792.6	852.9	919.2	995.5	1,074.7	1,156.4
			Expense	millionLE	579.8	723.7	707.3	767.3	833.0	908.1	985.8	1,065.7
			Profit	millionLE	22.6	-2.1	85.4	85.6	86.2	87.4	88.9	90.8
		Price & Unit	Sales price of Domest	LE/TON	529.0	564.3	652.0	687.0	724.1	764.0	808.1	857.2
			Sales price of Export	LE/TON	529.0	564.3	595.3	627.3	661.1	697.6	737.8	782.7
			Sales price of Bunker	LE/TON	529.0	564.3	595.3	627.3	661.1	697.6	737.8	782.7
			Invoice cost	LE/TON	529.0	564.3	595.3	627.3	661.1	697.6	737.8	782.7
			Import cost	LE/TON	554.2	591.2	623.7	657.2	692.6	730.8	772.9	819.9
			Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production cost	LE/TON	503.8	537.4	567.0	597.4	629.6	664.4	702.7	745.4
			Profit per unit	LE/TON	21.0	-1.7	68.4	66.7	65.1	63.9	63.4	63.5
			ROI	%	4.2	-0.3	12.1	11.2	10.3	9.6	9.0	8.5

(7) Supply Balance Forecast of Diesel

+ Diesel has shortage of supply because the domestic demand goes up due to the increase in automobiles. The estimated share of diesel import in the base case is about 36% in 2005.

+ As an energy supply planning issue, providing diesel from other countries will become a problem.

Table 6.3.15 Energy Balance of Diesel Oil

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Diesel	Consumpti	Solution	Domestic demand	KTON	6,612.0	7,000.3	7,412.5	7,845.8	8,307.6	8,806.6	9,353.0	9,957.9
			Export	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	KTON	243.0	243.0	243.0	243.0	243.0	243.0	243.0	243.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Transformation Initial-S	KTON	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
			Own use	KTON	453.1	468.2	479.2	489.6	500.2	512.6	520.5	523.0
			Total	KTON	7,429.1	7,832.6	8,255.7	8,699.4	9,171.8	9,683.2	10,237.5	10,844.9
		UpperLimit	Domestic demand	KTON	6,612.0	7,000.3	7,412.5	7,845.8	8,307.6	8,806.6	9,353.0	9,957.9
			Export	KTON	0.0	U	U	U	U	U	U	U
			Bunkers	KTON	243.0	243.0	243.0	243.0	243.0	243.0	243.0	243.0
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Domestic demand	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Export	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	6,060.8	6,237.2	6,377.3	6,509.4	6,643.2	6,801.5	6,896.2	6,916.5
			Import	KTON	1,368.4	1,595.4	1,878.4	2,190.0	2,528.5	2,881.7	3,341.2	3,928.4
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	7,429.1	7,832.6	8,255.7	8,699.4	9,171.8	9,683.2	10,237.5	10,844.9
		UpperLimit	Capacity	KTON	U	U	U	U	U	U	U	U
			Production	KTON	U	U	U	U	U	U	U	U
			Import	KTON	U	U	U	U	U	U	U	U
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Capacity	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	81.6	79.6	77.2	74.8	72.4	70.2	67.4	63.8
			Import rate	%	18.4	20.4	22.8	25.2	27.6	29.8	32.6	36.2
			Bought rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	3,943.7	4,440.5	4,944.6	5,498.1	6,117.5	6,824.1	7,642.3	8,604.2
			Expense	millionLE	3,811.9	4,295.3	4,787.2	5,328.0	5,933.9	6,624.8	7,428.2	8,376.6
			Profit	millionLE	131.8	145.2	157.4	170.0	183.6	199.3	214.1	227.6
		Price & Unit	Sales price of Domest	LE/TON	554.2	591.2	623.7	657.2	692.6	730.8	772.9	819.9
			Sales price of Export	LE/TON	554.2	591.2	623.7	657.2	692.6	730.8	772.9	819.9
			Sales price of Bunkers	LE/TON	554.2	591.2	623.7	657.2	692.6	730.8	772.9	819.9
			Invoice cost	LE/TON	251.9	268.7	283.5	298.7	314.8	332.2	351.3	372.7
			Import cost	LE/TON	554.2	591.2	623.7	657.2	692.6	730.8	772.9	819.9
			Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production cost	LE/TON	503.8	537.4	567.0	597.4	629.6	664.4	702.7	745.4
			Profit per unit	LE/TON	17.7	18.5	19.1	19.5	20.0	20.6	20.9	21.0
			ROI	%	3.5	3.4	3.4	3.3	3.2	3.1	3.0	2.8

(8) Supply Balance Forecast of Fuel Oil

+ Fuel oil is in surplus until 2004. In the base case, however, the surplus drains from 2005.

+ As an energy supply planning issue, whether fuel oil can be exported or not becomes a problem when an incremental plan for refinery plants is established. If fuel oil cannot be exported, fuel oil is consumed in the domestic market.

Table 6.3.16 Energy Balance of Fuel Oil

ITEMS 1	ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Fuel oil	Consumpti	Solution	Domestic demand	KTON	4,350.0	4,388.4	4,426.1	4,463.3	4,499.9	4,536.1	4,571.9	4,607.4
			Export	KTON	1,366.0	1,664.4	1,220.0	1,049.3	917.4	668.7	272.3	0.0
			Bunkers	KTON	2,268.0	2,332.8	2,402.8	2,383.1	2,293.7	2,336.1	2,349.7	2,353.1
			Payable	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Transformation to Pov	KTON	4,329.0	4,675.3	5,049.3	5,453.3	5,889.6	6,360.7	6,869.6	7,419.1
			Own use	KTON	538.1	556.0	569.0	581.4	593.9	608.7	618.0	621.0
			Total	KTON	12,851.1	13,617.0	13,667.2	13,930.4	14,194.6	14,510.3	14,681.6	15,000.6
		UpperLimit	Domestic demand	KTON	4,350.0	4,388.4	4,426.1	4,463.3	4,499.9	4,536.1	4,571.9	4,607.4
			Export	KTON	1,366.0	U	U	U	U	U	U	U
			Bunkers	KTON	2,268.0	2,332.8	2,402.8	2,383.1	2,293.7	2,336.1	2,349.7	2,353.1
			Payable Sales price o	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Domestic demand	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Export	%	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bunkers	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply	Solution	Initial-Stock	KTON	0.0	233.1	0.0	0.0	0.0	0.0	0.0	0.0
			Production	KTON	13,084.2	13,383.8	13,667.2	13,930.4	14,194.6	14,510.3	14,681.6	14,683.7
			Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	316.9
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable Fm Differe	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Final-Stock	KTON	-233.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	KTON	12,851.1	13,617.0	13,667.2	13,930.4	14,194.6	14,510.3	14,681.6	15,000.6
		UpperLimit	Capacity	KTON	U	U	U	U	U	U	U	U
			Production	KTON	U	U	U	U	U	U	U	U
			Import	KTON	0.0	0.0	0.0	U	U	U	U	U
			Bought	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sufficient ra	Capacity	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Bought	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Supply rate	Production rate	%	101.8	98.3	100.0	100.0	100.0	100.0	100.0	97.9
			Import rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
			Bought rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profitability	Profit	Income	millionLE	2,380.5	2,670.5	2,827.6	3,036.9	3,261.2	3,517.8	3,764.4	4,080.2
			Expense	millionLE	2,167.6	2,469.3	2,570.5	2,760.8	2,964.8	3,198.0	3,422.2	3,717.1
			Profit	millionLE	212.9	201.2	257.1	276.1	296.5	319.8	342.2	363.1
		Price & Uni	Sales price of Domest	LE/TON	182.2	196.1	206.9	218.0	229.8	242.4	256.4	272.0
			Sales price of Export	LE/TON	182.2	196.1	206.9	218.0	229.8	242.4	256.4	272.0
			Sales price of Bunkers	LE/TON	182.2	196.1	206.9	218.0	229.8	242.4	256.4	272.0
			Invoice cost	LE/TON	182.2	196.1	206.9	218.0	229.8	242.4	256.4	272.0
			Import cost	LE/TON	182.2	196.1	206.9	218.0	229.8	242.4	256.4	272.0
			Bought cost	LE/TON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Production cost	LE/TON	165.7	178.3	188.1	198.2	208.9	220.4	233.1	247.3
			Profit per unit	LE/TON	16.6	14.8	18.8	19.8	20.9	22.0	23.3	24.2
			ROI	%	10.0	8.3	10.0	10.0	10.0	10.0	10.0	9.8

6.4 Simulation Results by Scenario

6.4.1 Scenario Setting

In order to find the problems related to future energy supply, it is needed to forecast future energy balance (2005) including the current energy policies. And the future policies and future plans should be examined for finding future energy supply problems. The base case of the energy supply planning model (ESPM) are prepared for the purpose.

. The following conditions are set for the base case of energy supply planning in Egypt. And the simulation results are shown in the following table.

Table 6.4.1 Preconditions of the Base Case

Items	Unit	2000	2001	2002	2003	2004	2005
Crude oil Capacity	KTON	40,000	40,000	40,000	40,000	40,000	40,000
Natural gas Capacity	KTON	20,000	20,000	20,000	20,000	20,000	20,000
Refinery Capacity	KTON	35,000	35,000	35,000	35,000	35,000	35,000
GCC Capacity	GWh	27,000	27,000	27,000	27,000	27,000	27,000
Power Capacity	GWh	72,000	76,000	81,000	86,000	91,000	96000
Power Demand	GWh	63,686	67,655	72,031	76,888	82,333	88,481
LPG Demand	KTON	2,503	2,688	2,874	3,062	3,257	3,463
Gasoline Demand	KTON	2,456	2,555	2,649	2,740	2,828	2,916
Diesel Demand	KTON	7,413	7,846	8,308	8,807	9,353	9,958

Table 6.4.2 Solutions of the Base Case

Solution	Unit	2000	2001	2002	2003	2004	2005
Crude oil production		39,853	40,000	40,000	40,000	40,000	40,000
Natural gas Production	KTON	13,625	14,423	15,289	16,230	17,250	18,355
Refinery Production	KTON	29,948	30,598	31,260	32,037	32,529	32,684
GCC Generation	GWh	31,407	33,920	36,633	39,564	42,729	46,148
Solar-Wind-Other Generation	GWh	445	914	1,289	2,048	3,407	4,000
Power shortage	GWh	0	0	0	0	0	0
LPG Import	KTON	699	789	871	947	1,024	1,105
Gasoline Import	KTON	161	206	244	271	314	381
Diesel Import	KTON	1,878	2,190	2,529	2,882	3,341	3,928
Profit	Mill LE	6,149	6,542	7,139	7,547	8,075	8,749

In the base case, LPG, Gasoline and Diesel are short for their demand and the energies are imported to meet their demand. To decease the shortage of the energies are the important issues for Egypt energy policy. Egypt is supposed to be unable to produce crude oil more than the current level. However, fortunately natural gas has potential to be produced more than the current. And also, Egypt will have technologies to improve refinery plant yields and power plant efficiencies. Then the following scenarios are set for simulating the energy supply after improving the issues.

Table 6.4.3 Scenario Setting for Energy Supply Policy

Scenario	Content
Base case	Including the current energy policies.
Scenario 1	After improving the yields of refinery plants, what is the effect to energy supply?
Scenario 2	Egypt cannot produce crude oil more than the current level. However, Egypt can buy crude oil from partners. How to utilize crude oil from partner?
Scenario 3	After improving the yields, how to utilize crude oil from partner?
Scenario 4	LNG business is planed in future. How much profit is it?
Scenario 5	The roles of renewable energies are expected. How much profit is it?

6.4.2 Simulation Results

(1) Scenario 1: Improving Refinery Yields

For resolving the shortage of several energies, it can be considered to improve the technical changes. Technical changes in energy production and transformation sectors mean the efficiency improvement of crude oil production and natural gas, yields of refinery in future. For simulating the effects, the efficiencies and the yields should be changed in ESPM, and the model is run.

1) Data Setting

(a) The yields of RF-LPG, Gasoline and Diesel are 10% up from 2001.

(b) Efficiency of FD-LPG is 10% up from 2001

(c) The yield of Fuel oil is 7% down and Naphtha is 11% down from 2001

2) Results in 2005/06

Import of LPG, Gasoline and Diesel decreased little. But the domestic energy supply is not enough to their demand in 2005 as the following table.

Table 6.4.4 Results of Scenario 1 (2005/06)

Solution	Unit	Base Case	Scenario 1	Rate
Crude oil production	KTON	40,000	40,000	0

Natural gas production	KTON	18,355	18,355	0
GCC Generation	KTON	46,148	46,148	0
LPG import	KTON	1,105	869	-21%
Gasoline import	KTON	381	128	-66%
Diesel import	KTON	3,928	3,237	-18%
Profit	Million LE	8,749	8,819	1%

(2) Scenario 2 : Increase Crude Oil from Partners

For decreasing import of petroleum products, this scenario is assumed to increase crude oil from partners at 20% to 2000.

1) Data Setting

The data of crude oil from partners are changed to 7,320 KTON from 2001 to 2005 instead of 6100 KTON in 2000.

2) Results in 2005/06

(a) In Scenario 2, LPG, Gasoline and Diesel still have the supply shortage.

(b) When crude oil from partners is increased more than 20%, the profit is decreased, it means that surplus petroleum products are increased.

(c) Then, Egypt cannot make well-balance of petroleum products under the current demand structure of petroleum products.

Table 6.4.5 Results of Scenario 2 (2005/06)

Solution	Unit	Base Case	Scenario 2	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	7,320	0
Natural gas production	KTON	18,355	18,378	0
GCC Generation	KTON	46,148	46,148	0
LPG import	KTON	1,105	1,092	-1%
Gasoline import	KTON	381	293	-23%
Diesel import	KTON	3,928	3,681	-6%
Profit	Million LE	8,749	8,858	1%

(3) Scenario 3 : Increase Crude Oil from Partner and Yields

For decreasing import of petroleum products, this scenario is assumed to increase crude oil from partner at 20% to 2000 and yields at 10% up.

1) Data setting

(a). The yields of RF-LPG, Gasoline and Diesel are 10% up from 2001.

(b). The efficiency of FD-LPG is 10% up from 2001

(c) The yield of Fuel oil is 7% down; Naphtha is 11% down from 2001 (d).The data of crude oil from partners are changed to 7,320 KTON from 2001 to 2005 instead of 6,100 KTON in 2000.

2) Results in 2005/06

(a). In scenario 3, LPG and Diesel still have the supply shortage.

(b). But Gasoline shortage is resolved.

(c) Egypt should be tried to improve the yields of refinery plants, it will make more well-balance of petroleum products.

Table 6.4.6 Results of Scenario 3 (2005/06)

Solution	Unit	Base Case	Scenario 3	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	7320	20%
Natural gas production	KTON	18,355	18,371	0
GCC Generation	KTON	46,148	46,184	0
LPG import	KTON	1,105	855	-23%
Gasoline import	KTON	381	0	-100%
Diesel import	KTON	3,928	2,963	-25%
Profit	Million LE	8,749	8,930	2%

(4) Scenario 4 : Installation of LNG Plant

This scenario makes a plan to install a LNG plant consumed Natural gas and makes foreign trade surplus increase.

1) Data setting

(a) Natural gas capacity is increased at 10% up per year from 2001 to 2005.

(b) LNG plant is operated with 5 million ton capacity from 2001 to 2005.

Table 6.4.7 Data Setting for Scenario 4

Capacity	Unit	2000	2001	2002	2003	20004	2005
Natural gas	KTON	20,000	22,000	24,200	26,620	29,282	32,210
LNG	KTON	0	5000	5000	5000	5000	5000

2) Results in 2005/06

(a) The profit increases by installing LNG Plant.

Base case	8,749 million LE in 2005
Scenario 4	9,533 million LE in 2005
Balance	+ 784 million LE in 2005

(b) By exporting LNG, Egypt can increase the profit at level of 9% to the Base case.

Table 6.4.8 Results of Scenario 4 (2005/06)

Solution	Unit	Base Case	Scenario 4	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	6100	0
Natural gas production	KTON	18,355	23,981	31%
LNG production	KTON	0	5000	
GCC Generation	KTON	46,148	46,148	0
LPG import	KTON	1,105	470	-57%
Gasoline import	KTON	381	276	-28%
Diesel import	KTON	3,928	3,838	-2%
Profit	Million LE	8,749	9,533	9%

(5) Scenario 5 : Renewable Energies substitute LPG Import

Renewable energies is supplied with 285 kton in 2005, and the renewable energies substitute LPG domestic demand. As the results, it is expected that LPG import decreases.

1) Data setting

(a). Renewable energies is supplied with 285 kton in 2005 and is consumed in residential sector.

(b). LPG demand is decreased as much as the supply of renewable energy

2) Results in 2005/06

(a) The profit increases with substitution of renewable energy.

Base Case 8,749 million LE in 2005

Scenario 4 8,818 million LE in 2005

Balance + 69 million LE in 2005

(b) By the substitution, Egypt can get higher profit at 1% than the base case.

Table 6.4.9 Results of Scenario 5 (2005/06)

Solution	Unit	Base Case	Scenario 5	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	6,100	0
Natural gas production	KTON	18,355	18,355	0
Renewable production	KTON	285	285	0
LPG import	KTON	1,105	822	-26%
Profit	Million LE	8,749	8,818	1%

6.4.3 Comparison of Strategy Indicators

(1) Comparison of the Base Case, and Scenario 1 to 5

The following table is the comparison with strategy indicators of the base case, and Scenario 1 to 5. The strategy indicators are value added, foreign trade and CO2 emission.

Table 6.4.10 Base Case and Scenario 1 to 5 (2005/06)

Scenarios	Value added in Energy sectors (million LE)	Energy foreign trade balance (million LE)	CO2 emission From all energies (Million ton as CO2)
Base case	8,749	-4,819	145.7
Scenario 1 Yields	8,819	-4048	145.7
Scenario 2 Bought	8,858	-4562	145.8
Scenario 3Yield+Bought	8,930	-3763	145.8
Scenario 4 LNG	9,533	-1618	145.7
Scenario 5 Renewable	8,818	-4732	145.7
Comments	Profit in LP model = Value Added	Energy Export - import - Bought	CO2 emission From-En- model-LP

(a) Value added : Defined by profit in LP model
The value added of each scenario is higher than the base case. And the good conditions of the value added are Scenario 3 and 4.
(b) Foreign trade : Defined by 'Export-Import-Bought' Foreign trade of scenarios 3 and 4 are also the good conditions.
(c) CO2 emission : Come from Environmental model
CO2 emission of Scenario 2 and 3 is comparably rather high than other scenarios. But the increase is small.

(2) Information for Energy Supply Policy

Scenario 3 and 4 are attractive Scenarios for Egypt, if the CO2 emission of the scenarios is permitted by the regulation of Egypt. The Scenario 3 and/or 4 should be selected as Egyptian energy policy in 2005.

The right column of '3+4' is one scenario that is implemented under the conditions of scenario 3 and scenario 4. The increase of crude oil from partners and LNG production are required in the scenarios 3 and 4. The energy policy will make the profit with 9.3% up to the base case.

Table 6.4.11 Comparison of the Base Case and Scenarios 3 and 4 (2005/06)

Solution	Unit	Base Case	Scenario 3	Scenario 4	3 + 4
Crude oil production	KTON	40,000	40,000	40,000	38,205
Crude oil Bought	KTON	6,100	7320	6100	7,320
Natural gas production	KTON	18,355	18,371	23,981	23,981
LNG production	KTON	0	0	5,000	5,000
GCC Generation	KTON	46,148	46,184	46,148	46,148
LPG import	KTON	1,105	855	470	169
Gasoline import	KTON	381	0	276	0
Diesel import	KTON	3,928	2,963	3,838	3,104
Profit	Million LE	8,749	8,930	9,533	9,566

7. Environmental Impact Analysis Model

7.1 Environmental Issues and Strategy

7.1.1 Environmental Issues

Environmental priorities in Egypt are the issues of air pollution, water pollution and land pollution. These three big issues are described in the Law Number 4 of 1994, the Environmental Law. Our main target here is to build Energy Economic Model to evaluate the effect of energy pricing and economic policies on energy situation and the environment in Egypt. Therefore, this study examines not only the energy consumption and the effects on economic activities but also the social and environmental protections. To keep the development sustainable in Egypt, the energy consumption must be compatible with economic activities and environmental protection activities. The environmental issue for fuel combustion, especially, is the air pollution. It is important to note that CO_2, SO_2 and NO_x emissions affect air pollution, and CO_2 especially affects global environmental issues. Other notable issues include TSP (Total Suspended Particles), which is mainly caused by open burning of crops, transportation activities and industrial production activities.

Egypt is known as the first developing country to give a great attention to environmental problems because it understands the importance of environmental protection and it's the environment's effects on humans. The environment was seriously affected by rapid technological developments. The technological development may be adversely affected by the environmental problems it caused. In this regard, Egypt has undertaken comprehensive development policies to harmonize with the environment.

Established by Presidential Decree No. 631 of 1982 as a Cabinet affiliate, the Egyptian Environmental Affairs Agency (the EEAA) observes various environmental aspects and plays a great role in addressing national issues on the environment. The Agency's main tasks were to create and apply environmental policies in collaboration with the Scientific Research and Technological Academy.

According to "Environmental Auditing" (Energy Conservation & Environmental Protection project, May 1994), the EEAA adopted the following procedures to minimize pollution.

- Protecting the Nile River and waterways
- Recycling sanitary drainage of river navigation
- Prevention of air pollution by manufacturing cement and dust filters locally

- Determining the ratio of vehicle exhaustion
- Setting up an environmental monitoring network
- Extension of green lands and installation of the windshields
- Laying down a legislative base to control pollution
- Examination of the impact of location and facility activities on the environment before the issuance of building authorization
- Minimizing the use of pesticides and chemical fertilizers
- Adopting modern methods in irrigation
- Prohibiting land scooping, building of installations and facilities on arable lands
- Supplying museums with ultra-violet filters on show windows
- Propagating environmental awareness among citizens, stressing the importance of law on the environment
- Establishing an information center to gather information about dangerous materials manufactured locally and externally
- Participation in various festivals, exhibitions, symposia and gatherings
- EEAA projects are either financed locally or externally through foreign aids (Danish-Swiss Aid)
- Enacted major Presidential decrees on environmental protection

In 1992, the Government of Egypt (GOE) released the Egypt Environmental Action Plan. This plan examined the environmental impact of urbanization and industrialization and the traffic and industrial activities and identified thermal power generation as major sources of air pollution nationally and in the Greater Cairo metropolitan area. The plan recommended the limitations on the use of command and control measures and the need for greater reliance on market-related incentives to increase the use of cleaner fuels and technologies in vehicles and industry.

The following eight actions were recommended:

1) Phase out energy subsidies to slow the growth in energy consumption and increase incentives for energy efficiency
2) Introduce a gasoline tax to reduce energy consumption and provide a source of public funds
3) Reduce lead in gasoline to decrease loading to the environment
4) Adopt other vehicle policies related to emissions testing, traffic management and mass transit alternatives
5) Lower vehicle and auto part import duties to encourage ownership of cleaner car
6) Reduce the use of high sulfur fuels through phasing out fuel subsidies and creation of a sulfur tax

7) Refine and develop emissions standards and enforcement mechanism, and improve industrial zoning
8) Develop public awareness of air pollution issues and associated costs

The Environmental Law (Law Number 4 of 1994), issued in 1994 and was enacted in 1995, opened a new era of environmental issues in Egypt. Details will be discussed in a later section.

Table 7.1.1 shows major air pollution in the Greater Cairo area. Air pollution levels in the Greater Cairo area are above the U.S. health-based standards and the World Health Organization (WHO) guidelines. The data, the most recent of this kind, are from 1991-1992, and may not reflect the current situations.

Table 7.1.2 shows the ambient air pollution levels of sulfur dioxide in the Greater Cairo area. The levels are above the U.S. and the WHO health-based standards (U.S. standard: 80 microgram/m^3; WHO guideline: 40-60 microgram/m^3).

Table 7.1.3 shows the annual mean concentrations of total suspended particles (TSP) at various monitoring sites within the Greater Cairo area. The concentrations exceed the WHO guideline and the former U.S. standard for TSP by factor of about 5-10. As we see in later sections, PM10 concentrations are higher than the standards provided by the Environmental Law. These situations show that air pollutions in the Greater Cairo area are in a very serious situation.

Table 7.1.1 Concentrations of Air Pollutants in Greater Cairo (microgram/m^3)

Pollutant	Concentration		U.S. Standard		WHO Guidline	
Sulfur Dioxide	40-156	annual mean	80	annual mean	40-60	annual mean
Particulate matter	349-857	annual mean	75	annual mean	60-90	annual mean
Nitrogen Oxides	90-750	hourly mean	100	annual mean	320	hourly mean(N2O)
Carbon Monoxide	1,000-18,000	hourly mean	40,000	hourly mean	10,000	8-hour mean
Lead	0.5-10	annual mean	2	quartly mean	0.5-1.0	annual mean
Ozone	100-200+	hourly maximum	235	hourly maximum	150-200	hourly mean

(Source) "A Comparative Risk Analysis of the Environmental Problems Affecting Cairo, Egypt"

Table 7.1.2 Concentration of Sulfur Dioxide in Greater Cairo (microgram/m^3)

Year	Cairo City			Shoubra El-Kheima		Helwan	
	Residential	City Center	Suburban	Industrial	Residential		
1991-	55	84	40			105	mean
1992	76	127	54			171	monthly max
	120	308	86			320	24-hr max
1990					96		mean
					176		24-hr max
1988	100			156		100	mean
				800			24-hr max
1993				104			mean
1979		260					mean
1978				67			mean

(Source) "A Comparative Risk Analysis of the Environmental Problems Affecting Cairo, Egypt"

Table 7.1.3 Annual Mean Concentrations of TSP in Greater Cairo(mg/m^3)

Year	Cairo City				Shoubra El-Kheima	Helwan
	City Center	City Centar High Traffic	Residential	Residential high traffic		Residential
1991	448	661	349	561		857
1990	495	658	375			
1989	632	699	548	602		1100
1988	649	704	602	548	528,680	838
1987	646	641	502	591		1161
1983		548		935	567	714
1978				495	503	

(Source) "A Comparative Risk Analysis of the Environmental Problems Affecting Cairo, Egypt"

7.1.2. Environmental Law and Strategy

On January 27, 1994, the Government of Egypt (GOE) issued the Environmental Law (Law Number 4 of 1994), which is said to be the first comprehensive environmental law in Egypt. It was enacted by Prime Minister's Decree No.338 of 1995, which was issued on February 18, 1995. Complying to the Environmental Law of 1994, the old Egyptian Environmental Affairs Agency was replaced to the new Egyptian Environmental Affaires Agency (the EEAA). According to this law, "The Agency shall formulate the general policy and lay down the necessary plans for the protection and promotion of environment and follow up the implementation of such plans in accordance with the competent administrative authorities. The Agency shall have the authority to implement some pilot projects".

The recent environmental policy in Egypt was based on the Environmental Law of 1994. The Egyptian Environmental Affaires Agency (the EEAA) is the main office to implement environmental policies in Egypt.

Before the Environmental Law of 1994 was issued, the Government of Egypt had made a number of decrees and regulations to preserve the environment in Egypt. Table 7.1.4 shows these laws and regulations that addressed air pollution problems. In respect to air pollution regulations, the following ministries and organizations have the responsibility. ("Environmental Auditing", Energy Conservation and Environment Protection Project, May 1994)

The EEAA
Ministry of Health
Supreme Committee for the Protection of Air from Pollution
Ministry of Housing
Ministry of Industry
Local Governments

Table 7.1.4 Laws and Regulations for Air Pollution Control

Law number/year	Suject of Law
Presidential Decree 864-1969	Establishes the Supreme Committee to protect air from pollution, chaired by the Minister of Health. Its mandate is to study sources air pollution, formulate a general policy for preventing air pollution, and set standard and criteria for air quality
Minister of Health Decree 470-1971; amended by decree 240-1979	Set standard for ambient and worlplace air. Includes: Gases & Vapors (47 materials Annex II) Dust & Suspended Matter (36 materials
Law number 106-1976; amended by law 30-1975	Concerns building regulations and the distance between buildings, and apertures in rooms and units.
Decree of Minister of Housing number 380-1975	Specifies the general conditions for public buildings such as commercial and industrial buildings and comprises rules for ventilation and avoiding severe heat, cold and humudity. Article 24 deals with fuenaces, chemneys and atalks. Many other ministerial
Law number 3-1982; implemented by Minister of Housing's decree 600-1982	An urban planning law that "designate areas and spaces for roads, squares, gardens and gives specifications for industrial areas"
Law number 148-1959; amended by law 10-196, 75-1981 and 107-1982	Concerns Civil Defense; Article 3 contains rules for protecting the environment as applied to workshops, public utilities and public buildings, and methods for dealing with natioal desasters.
Law 66-1973, amended by laws 210-1980 and 20-1983. Decree 291-1974 of the Minister of Interior amended by decree 407-1983	Concerns traffic; chapter 5 of the law deals with traffic rules concerning car exhaust; it prohibits "heavy smoke".
Law 137-1981, implemeted by decree issued by the Minister of manpower number 55-1983	For labor, this regislation determines the amount of fresh air per person in the workplace, the suitable temperature and humidity levels.
Law number 27-1981	For worlers in mines and quarries determining the amount of lighting, ventilation and temperature inside the mines, and rules to prevent the increase of cast and vapors.
Law number 52-1981, implemented by the decree issued by the Minister of Health number 1-1982	To combat the hazards of smoking, smoking is prohibited in public transport and closed public places.
Law 59-1960, implemented by the Minister of health decrees 630-1962, 444-1972, 87-1984	Regulates use and protection from ionizing radiation, shows how to avoid exosure to ionizing radiation and setting maximum exposure limits.
Decree of the Minister of Industry number 380-1982	Necessiates the use of protective equipment to prevent pollution resulting from the use of technology in new industrial projects.

(Source) “Environmental Audit”, Energy Conservation and Environment Protection Project, May 1994.

In the field of air pollution, CAIP is a very important project that represents a major opportunity to implement several priority recommendations of the GOE’s environmental management agenda. This project, which includes a pilot VET program, CNG, LPA and AQM, is given a very high priority.

(1) Law Number 4 of 1994 (the Environmental Law)

The Environmental Law is composed of Preliminary Part, Part One, Part Two, Part Three, Part Four and Final Provisions.

Preliminary Part defines General Provisions, Egyptian Environmental Affaires Agency, Environmental Protection Fund and Incentives.

To implement the objectives of protecting and promoting the environment in Egypt, the EEAA was newly established and given the authority to implement the following items.

1) Preparing studies on the state of environment and formulating the national plan that include projects to protect the environment.
2) Laying down the criteria and conditions that owners of projects and establishments must observe before the start of construction and during the operation of the project.
3) Gathering, publishing, evaluating and utilizing national and international information on environmental conditions for environmental management and planning.
4) Participating in the preparation and implementation of national programs for environmental monitoring.
5) Compiling and publishing periodical reports on major environmental indicators.

The Prime Minister's Decree No. 338 of 1995 gives the EEAA Board of Directors the following authority.

1) Approve national plans to protect the environment.
2) Approve contingency plans to deal with environmental disasters.
3) Draft laws concerning the environment.
4) Approve experimental projects to be undertaken by the EEAA.
5) Approve experimental training policies and plans.
6) Set parameters to define pollution level. 7) Approve standards and procedures for assessing the environmental impact of projects.
8) Supervise the fund for protection and development of the environment.
9) Approve the organizational structure of the EEAA.
10) Approve the by-law and personnel regulations of the EEAA.
11) Consider all matters that the Chairman of the Board deems worthy to be presented, in line with the EEAA's scope of responsibilities.
12) Determine which resolution should be submitted to the Cabinet for approval. Any resolution submitted to the Cabinet by the Board of Directors must be accompanied by

the implementation cost study and the projected result study.

Another important outcome from the Environmental Law is a special fund named the "Environmental Protection Fund" in the EEAA. The fund provides eight categories of financial resources, including subsidized budget (allocated in the state budget to subsidize the fund), grants and donations (presented by national and foreign organizations for the purpose of protecting and promoting the environment and accepted by the Board of Directors of the EEAA) and fines and compensations (for damages caused to the environment).

This financial resource can be used to implement its objectives described below.

1) Confronting environmental disasters.
2) Experimental and pioneering projects in the field of protecting natural wealth and the environment from pollution.
3) Transfer of low cost technologies whose application was proven to be successful.
4) Financing the manufacture of model equipment, machinery and plants for handling environmental pollutants.
5) Establishing and operating Environmental Monitoring Networks.
6) Establishing and administering Nature Reserves in order to preserve natural wealth and resources.
7) Confronting pollution from unknown sources.
8) Financing the studies required to prepare environmental programmes, assessing environmental impact and determining the standards and criteria that must be observed in order to protect the environment.
9) Financing environmental protection projects undertaken by local administrative agencies and grass-roots organizations that are partially financed through popular participation.
10) Projects to combat pollution.
11) Disbursing rewards for outstanding achievements in the area of protecting the environment.
12) Consolidating the basic structure of EEAA and developing the activities.
13) Other objects aimed at protecting and developing the environment that are approved by the EEAA Board of Directors.

Part One, Three and Four are devoted to the protection of land environment, the protection of water environment and the penalties. Particularly important for the purpose of our study is Part Two, which deals with "Protection of Air environment from pollution". According to the report "Environmental Auditing", Part Two is summarized as follows.

Establishments covered by the law (industrial and tourist establishments, oil and power industries, and mining industry, etc.) need permits to build or operate. Their air pollutants may not exceed the emissions standards or the ambient standards.

Rapid transport vehicles shall meet the exhaust emission limits. Table 7.1.6 describes the standards defined by the Environmental Law.

Regulations ensure that construction waste and dust will not be dispersed.

Fuel burning for industrial, energy, construction, or any purpose may be excercised within permissible limits and with appropriate precautions and technologies. Air pollutants from fuel burning that are gaseous, solid, liquid or steam pollutants emitted by various establishments within given periods are likely to impact adversely on public health, animals, plants, material or property and interfere with everyone's daily life.

Extraction of crude oil, and its refining, will contain the impacts within permissible limits through efficient control measures and permits.

Table 7.1.5 Maximum Limit of Outdoor Air Pollutants (microgram /m^3)

POLLUTANT	MAXIMUM LIMIT	EXPOSURE PERIOD	Japanese Srandard
Sulphur Dioxide	350 150 60	1 hr 24 hrs 1 year	285 114
Carbon Monoxide	30 Milligrams/cubic meter 10 Milligrams/cubic meter	1 hr 8 hr	12.5 10
Nitrogen Dioxide	400 150	1 hr 24 hrs	 123
Ozone	200 120	1 hr 8 hr	128
Suspended Particles Measured as Black Smokes	150 60	24 hrs 1 year	
Total Suspended Particles (TSP)	230 90	24 hrs 1 year	
Respirable Particles (Pm 10)	70	24 hrs	100
Lead	1	1 year	

(Source) Law Number 4 of 1994

Table7.1.6 Maximum Limit for Vehicle

1. Vehicles currently in service:	
Carbon Monoxide:	7% in volume at the speed of (600-900 R.P.M.)
Unburned Hydrocarbons:	1000 parts in a million, at the speed of (600-900 R.P.M.)
Smokes	65% degree of opacity or the equivalent in other units, at minimum acceleration
2. New vehicles licensed as of 1995:	
Carbon Monoxide:	4.5% in volume at the speed of (600-900 R.P.M.)
Unburned Hydrocarbons:	900 parts in a million, at the speed of (600-900 R.P.M.)
Smokes	50% degree of opacity or the equivalent in other units, at maximum acceleration.

(Source) Law Number 4 of 1994

Table 7.1.7 Permissible Limits of Air Pollutants

S. No.	Kind of Activity	Maximum Limit for Emissions) (miceogram/m^3 from Exhaust
1	Carbon Industry	50
2	Coke Industry	50
3	Phosphates Industry	50
4	Casting and extraction of lead, zinc, copper, and other non-ferrous metallurgical industries.	100
5	Ferrous Industries	200 Existing 100 New
6	Cement Industry	500 Existing 200 New
7	Synthetic woods and fibers	150
8	Petroleum and Oil Refining Industries.	100
9	Other Industries	200

(Source) Law Number 4 of 1994

(2) Cairo Air Improvement Project (CAIP)

The Cairo Air Improvement Project (CAIP) is funded by the United States Agency for International Development (USAID) and is implemented in partnership with the Egyptian Environmental Affairs Agency (EEAA) and the Organization for Energy Planning (OEP). Its goal is to plan and implement measures to reduce air pollutants, especially suspended particulates and lead, which have the most serious impacts on human health in the Greater

Cairo area..

Four major activities of CAIP are VET, CNG, LPA and AQM.

The objective of VET, "Vehicle Emission Testing, Tune-Up, and Certification", is to improve the fuel efficiency of and reduce exhaust emissions from gasoline-fueled vehicles licensed in the Greater Cairo area through testing vehicle emissions, enhancing tune-up capabilities and initiating vehicle certification requirements.

The pilot VET program (a low-cost tune-up) is reported to have demonstrated a significant reduction of HC and CO emissions (35 and 62 %, respectively) and higher fuel efficiencies (averaging nearly 15 %). Key activities in the first year of the program were centered around establishing technical and policy foundations for controlling emissions from motor vehicles.

Overall goals of the VET component include:

1) Reducing vehicle emissions through achieving an 80% compliance rate among Cairo's fleet of private vehicles by the project end

2) Improving the average fuel efficiency of tuned-up vehicle by 10%

The objective of CNG, "Compressed Natural Gas", is to reduce the total suspended particulate emissions from diesel-fueled buses through expanded use of compressed natural gas in the fleet of public municipal buses.

Converting gasoline vehicles to CNG substantially reduces harmful emissions into the environment while saving an estimated fuel cost of 40%. Thousands of cars, mostly taxis and private sector mini-buses, are reported to be converting to CNG each year.

The goals of the CNG component include:

1) Procurement of pilot fleet of 50 CNG buses divided equally between the Cairo Transit Authority (CTA) and Greater Cairo Bus Company (GCSC)
2) Developing a plan for prototype large-scale conversion of diesel buses to natural gas buses
3) Developing a plan for large-scale CNG commercial fleet with sustainable resources
4) Building a state-of-the-art emission testing facility at Misr Petroleum Laboratory
5) Establishing comprehensive safety standards and regulations for the components and applications of CNG in vehicles and fuel stations
6) Developing a comprehensive natural gas applications training program for fleets

7) Offering technical support and consultation to private CNG fleets

The objective of LPA, "Lead Pollution Abatement", is to support the implementation of the Government of Egypt's Lead Smelter Action Plan. The goal of this plan is to relocate the lead smelters to industrial areas to reduce airborne lead emissions. Recent environmental studies established that lead was a major component of air pollution in Cairo. Polluting emissions have accumulated in the dust for decades since there are no regular heavy rainfalls to wash them away. Lead smelters in and around Cairo have been identified as a major source of lead exposure, and lead particulate emitted from smelters is in excess of the maximum permissible limits defined by the law.

When the activities contained in the smelter action plan are completed, the following results are expected to be achieved.

1) A 95% reduction of airborne lead emissions from lead smelter in workplace
2) Emission at lead smelters will be monitored to assure continued compliance with Egyptian environmental laws.
3) Within 5 years, all lead smelters will have been relocated from densely populated areas.

The objective of AQM, "Air Quality Monitoring Program", is to institute an air quality monitoring and analysis program for the Greater Cairo area, to collect baseline data and to measure the results from implementation of the Government of Egypt's intervention.

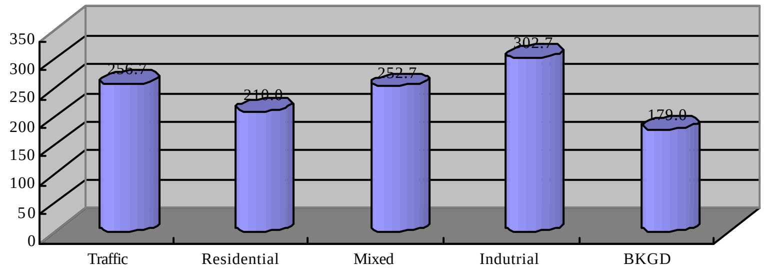
AQM measures Pb and particulate matter (PM) levels in the air in the Greater Cairo area. By August 1998, 36 stations were installed and operated on a continuous basis in the Greater Cairo area. The initial objective of AQM was an accurate and comprehensive determination of the current PM and Pb levels in the PM10 and PM2.5 size ranges. This baseline data will be used to judge the effectiveness of future programs to reduce particulate matter and lead in the ambient air.

The goal of AQM is to achieve sustained operation of the monitoring effort to be able to demonstrate the improvement of air quality. Table 7.1.8 lists CAIP monitoring sites. Figure 7.1.1 illustrates the result of air monitoring in the Greater Cairo area.

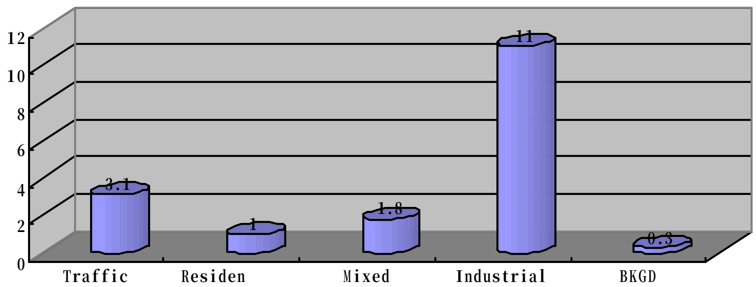
Figure 7.1.1 shows that all of the monitoring site data are over PM10, the standard defined by the Law. Industrial zones and traffic zone indicate especially high level of PM in the air. Industrial zones include cement factories, foundries, smelters and other industries. The reason for the high exhaust in the traffic zones is the congested traffic activities of cars, trucks and buses.

It is important to note that these data are derived from the 3 months period of a short-term monitoring activity. It may not be reasonable to make a definitive judgment on whether the data are exceeding the standard.

Figure 7.1.1 Mean PM10 Concentrations by Site, September - November, 1998



(Note) The Law No.4 PM10 standard is 70 mirogram/m^3 (24-hour average)



(Note) The Law No.4 PM10 standard is 1 mirogram/m^3 (Year average)

Table7.1.8 The CAIP Ambient Air Monitoring Network

CAIP Site # (a)	Site Name	Start Of Operation (1998)	Site Type	UTM Coordinates Northing	Easting	CAIP PM 2.5	PM10	PM10 HV	MET	Equipment at DANIDA/EIMP Sites SO2(C)	NOx(C)	PM10(1)	HC(C)	O3(C)	CO(C)	MET	PM10(24)	TSP	VOC	SO2, FP	NO2, FP	2 Filters	Pass. Slpr.	Dustfall
1*	El Qualaly Square	1-Aug-98	Traffic	330594	3326603	X	X			X	X	X						X	X					
2	El Gemhoroya Street	8-Aug-98	Traffic	330945	3326512	X	X																	
3*	Kobry El Kobba	8-Aug-98	Urban/Res	335190	3328951	X	X			X				X		X								
4*	Nasr City	27-Jun-98	Residential	338816	3325866	X	X										X			X	X			X
5*	Fum Al-Khalig	Shelter	Traffic	329358	3322702		X			X	X		X		X		X							
6	Maadi/CAC	22-May-98	Residential	333471	3315496	X	X																	
7*	Tebbin South	27-Aug-98	Industrial	336948	3292317	X	X											X	X	X		X		
8	Old Cairo/UHC	27-Jun-98	Urban	329469	3321031	X	X																	
9	Square	23-Aug-98	Traffic	330905	3326920		X																	
10	Maadi/CAIP	22-May-98	Residential	331076	3315847	X	X		F															
11	Giza/CEH	22-May-98	Residential	327125	3323063	X	X																	
12	Darassa/AAU	19-Aug-98	Urban	332644	3325152		X																	
13*	6th October City	27-Aug-98	Residential	298716	3313591	X	X										X			X	X			
14*	10th Ramadan City	15-Aug-98	Residential	378586	3351235	X	X										X			X			X	X
15	Bilbeis	22-May-98	Background	358434	3356629	X	X		FS															
16	Mokotam	Approved	Residential	335413	3321420		X																	
17	Shobra Kheima/ ADW	28-May-98	Industrial	333190	3332439	X	X																	
18	Shobra Kheima/APC	15-Jun-98	Industrial	332797	3332591	X	X																	
19	Shobra Kheima/TTI	9-Jun-98	Industrial	332511	3332027	XC	XC																	
20	Shobra Kheima/MICAR	9-Jun-98	Industrial	334295	3332842	X	X																	
21	Matarya	19-Aug-98	Ind/Res	337635	3333406	X	X																	
22	El Waily	1-Aug-98	Ind/Res	333996	3330857		X	X																
23	Tebbin/ES/UW	15-Jun-98	Industrial	335006	3295144	X	X																	
24	Tebbin/GM/DW	3-Jun-98	Industrial	335342	3294703	XC	XC		F															
25	Imbaba	27-Aug-98	Residential	328829	3329039		X																	
26	Kaha	27-Jun-98	Background	326517	3350606	X	X		FS															
27	15th May City	3-Jul-98	Residential	342241	3299968	X	X																	
28	Almaza	26-Aug-98	Residential	340774	3329357		X																	
29	Basateen	23-Aug-98	Ind/Res	331495	3318364		X																	
30	Giza/CYC	8-Aug-98	Residential	328339	3323867		X																	
31	Tahrir Square	22-May-98	Urban	329990	3324855	X	X		P															
32	Zamalek	21-Jun-98	Residential	328661	3326590	X	X																	
33	Helwan	22-May-98	Residential	338983	3302944	X	X																	
34	El Massara	22-May-98	Ind/Res	335395	3309097	X	X																	
35	Heliopolis	28-May-98	Residential	339733	3331676	X	X																	
36	Abbasia	22-May-98	Industrial	334658	3327037	X	X	X																

Another monitoring system, Environmental Information and Monitoring Program, aims to establish national environmental monitoring programs for ambient air and coastal waters and to build environmental quality data and database system. This program was started in January 1996. The EEAA is the executing agency for the program, and Danida (Danish International Development Assistance) is the sponsor to provide the foreign contribution. As for the air pollution monitoring, data are collected using automatic on-line monitors and various sampling equipments. A total of 39 sites, of which 7 sites is collocated with CAIP monitoring sites, covering all of Egypt has been selected. Important indicators selected by EIMP are SO_2, NO_2, PM10, CO, O_3, non-methane hydrocarbons (NMHC) and lead.

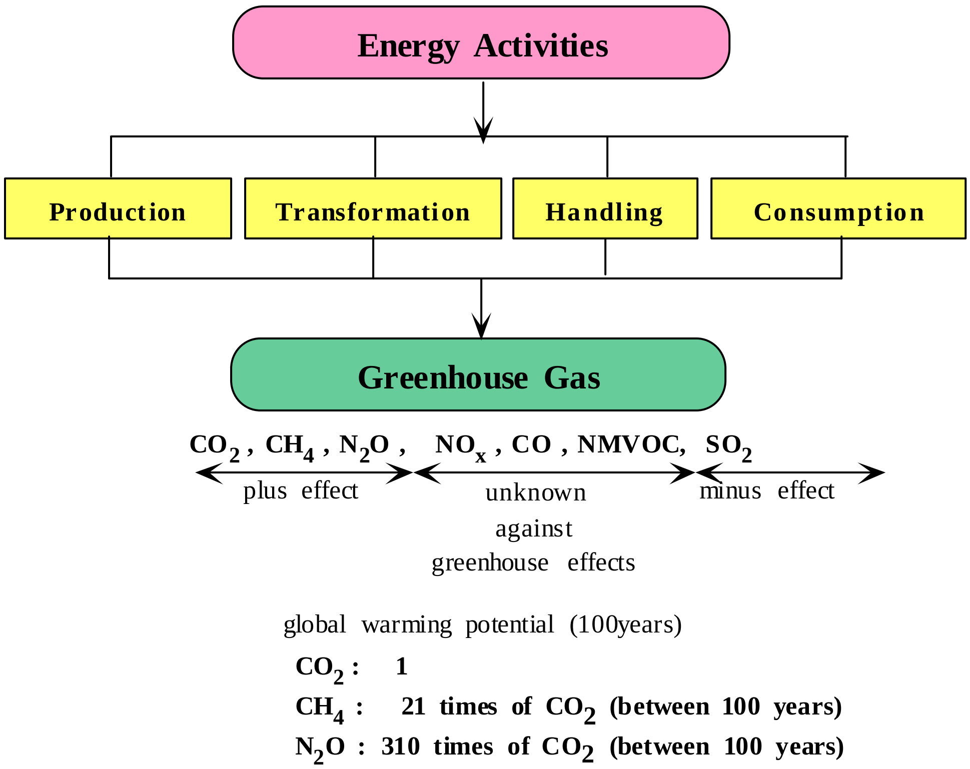
7.2 Environmental Analysis Model and the Results

Through a strict estimation of 6 GHG and SO_2 emissions, the study addresses the relationships between the fuel combustion and the emitted gases and the effect on economic activities in Egypt.

7.2.1 IPCC Guidelines for the Estimation of GHG Emissions

IPCC (Intergovernmental Panel on Climate Change) makes the guidelines for the GHG emissions calculation method for countries that does not have their own estimation method for GHG emissions. In IPCC guidelines, IPCC addresses following 6 GHGs: CO_2, NO_x, CH_4, N_2O, CO and NMVOC (non-methane volatile organic compounds) and the air pollution material SO_2 (Hereafter, SO_2 is included to GHG for shortening the word). These gases are emitted from the production, transformation, handling and consumption of energy commodities. Furthermore, these gases are by-products in industrial processes, mainly from utilization of a limestone ($CaCO_3$) in the cement industry and the iron industry.

Figure 7.2.1 General Idea for GHG Emissions



(Source) "IPCC Guidelines for national Greenhouse Gas Inventories, 1996" and "Climate Change, 1995,the Science of Climate Change,1995"

According to IPCC guidelines, there are four methods— "Tier 1", "Tiers 2,3" and two other methods (See Table 7.2.2). Each method has its own advantages and disadvantages. Many countries have been estimating their GHG emissions with "Tier 1" method mainly, supplemented with "Tier 2,3" and two other methods.

"Tier 1" method is a simple and transparent method for estimating GHG emissions because of the availability of energy data from the production to the consumption by energy sources in each country. Using more detailed fuel and technology information, "Tiers 2,3" method focuses the estimation of GHG emissions in stationary and mobile sources. But "Tier 1" method is better than "Tiers 2,3" method to understand overall environmental situation in each country.

Figure 7.2.2 Estimation Methodology of GHG Emissions by IPCC

Simple Methods(Tier 1)

Emissions from all sources of combustion are estimated on the basis of quantities of fuel consumed and average emission factors.

Detailed Methods(Tiers 2/3)

Emission Estimations are based on detailed fuel/technology information covering stationary and mobile sources

Fugitive emissions from coal mining and handling

Emissions are generated as a result of the mining and handling of coal, primarily methane emissions from coal mining.

Fugitive emissions from oil and gas activities

Methane emissions from natural gas flaring and venting, and from natural gas production, transmission and distribution are the most important factor in this category.

(Note) "IPCC Guidelines for national Greenhouse Gas Inventories, 1996"

For the estimation of CO_2 emission, the IPCC reference approach (Tier 1) was used because, as mentioned before, this approach of CO_2 emission estimation is simple and internationally transparent. CO_2 from energy activities can be estimated based on energy data, with a few adjustments--e.g., for carbon de-oxidized. IPCC guidelines show that, if possible, national inventories should be prepared using local emission factors and energy data because fuel quantities and emission factors may differ markedly between countries.

Excluding CO_2, national inventories of SO_2, NO_x, CH_4, N_2O, CO and NMVOC require more detailed information. An accurate estimation of their emissions depends on the information of several interrelated factors, including combustion conditions, technology and emission control policies, as well as fuel characteristics.

7.2.2 Flow Chart for the Estimation of GHG Emissions

In this study, GHG emission in Egypt was estimated as follows. First, "Energy Balance Table" was prepared based on the original Egyptian energy data made by OEP and "Emission Factors of GHGs". The Egyptian net calorific value for each energy source, depending on the IPCC calculation method, was used to calculate the emission factors of CO_2. IPCC data was used for the non-CO_2 emission factors, excluding SO_2 and NO_x, because it is difficult at present to obtain sufficient information about the data needed for calculating non-CO_2 emission factors. The method used by the Science and Technology Agency (STA) of Japan was employed for NO_x emission factors. In November 1991, STA published a report called "NISTEP REPORT No.21" that analyzed SO_2, NO_x and CO_2 emissions in Asian countries. This study was a comprehensive study to estimate the environmental situations in Asia. The study team compared the SO_2 and NO_x emission factors from this report with the IPCC emission factors in order to get more accurate estimation.

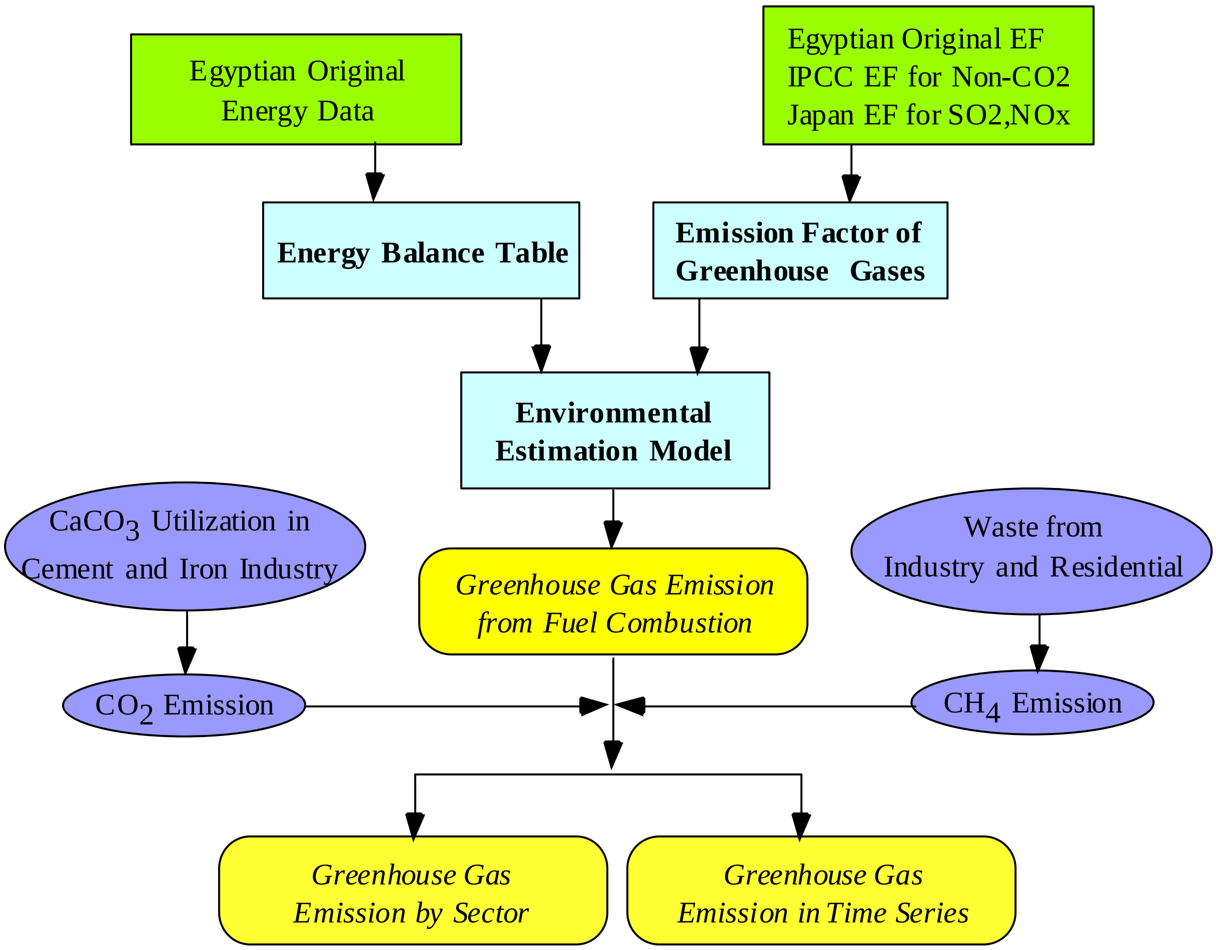
The study team developed "Environmental Analysis Model" for estimating the GHG emissions using "Energy Balance Table" and "Emission Factors of GHGs" mentioned earlier. This model is an Excel-based calculation sheet. Basically, the amounts of GHG emissions are obtained from multiplying energy consumption and emission factors for each energy source. At this time, the de-oxidized fraction of CO_2 and the fuel combustion conditions of non-CO_2, especially NO_x, were considered. This model has two parts--one for annual estimation of GHG emissions that details the structure of environmental situation, and the other for the estimation of GHG emissions in time series.

Therefore, we have two output sheets--one for the annual data sheet and the other for the time series data sheet. Also the outputs include GHG emission intensities per GDP and per Capita through dividing GHG emissions by GDP and the number of population.

These two tables and one model are included in one file and linked automatically with each other. Therefore, when "Energy Balance Table" obtained through the result of simulation by Econometric Macro Model and LP Model is prepared for the estimation, the results of estimation of GHG emissions are recorded automatically on the Excel sheets.

When the situation changes, it should be reflected by adjusting data in "Environmental Analysis Model", which has emission factors of GHG and other prepositions.

Figure 7.2.3 Flow Chart for the Estimation of GHG Emissions in Egypt



7.2.3 Energy Balance Table made by this Study

The study team made "Energy Balance Table" using Egyptian original energy data and internationally adopted calculation method to understand the energy situation in Egypt and to forecast the future energy situation using Econometric Macro Model and LP Model developed in this project. Although the detailed structure of "Energy Balance Table" is explained in Chapter 8, this section gives a brief explanation.

The table has 63 energy supply (production), transformation and consumption sectors (row) and 28 energy sources (column). Due to the lack of energy data, this table is not filled out completely, but we can use this table for analyzing and forecasting energy demand and supply situation in Egypt.

Total Primary Energy Supply (See Table7.2.1) has production, import, export, marine bunkers, stock changes and, especially, partner share in Egypt. Next is the Transformation Sector, which includes the Power Generation Sector, the Coke Oven Coke Sector (Iron industry and others) and the Oil Refineries Sector. The Oil Refineries Sector shows only transformation from crude oil to oil products and does not include energy consumption in refining operation. This energy consumption is included in Energy Sector Use (Oil Refinery Use). The Total Final Consumption (Supply) is obtained by subtracting the energy supply in the Transformation Sector and Energy Sector Use from the energy supply in the Total Primary Energy Supply.

The Total Final Consumption consists of Industry Sector, Transport sector and Other Sectors, including Agriculture, Commercial, Residential, etc. Non-Energy Use means feedstock for Chemical and Fertilizer industries, in which Non-Energy Use is not burned and GHGs are not emitted.

Table 7.2.1 Brief Summery of Energy Balance Table (1997,Total) (Unit;KTOE)

Item	Coke_C	COC	NG	Crude_Oil	NGL	LPG	Gasoline	Jet
Indigenous Production	0.0	0.0	11,787.7	40,091.5	1,861.9	0.0	0.0	0.0
Partners Share	0.0	0.0	-3,085.2	-14,689.2	-571.4	0.0	0.0	0.0
From Partners	0.0	0.0	3,016.4	6,194.9	255.9	0.0	0.0	0.0
Import	1,321.2	0.0	0.0	0.0	0.0	595.1	93.9	0.0
Export	0.0	-324.8	0.0	-3,948.2	0.0	0.0	0.0	-112.9
International Marine Bunkers/Aviation	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-397.5
Stock Changes	0.0	0.0	0.0	-413.0	0.0	3.4	32.0	0.0
Total Primary Energy Supply	1,321.2	-324.8	11,718.8	27,236.1	1,546.4	598.5	125.7	-510.4
Transformation Sector	-1,321.2	1,008.0	-7,748.1	-27,236.1	-1,546.4	518.6	2,335.1	951.3
Public Electricity Plants	0.0	0.0	-7,228.2	0.0	0.0	0.0	0.0	0.0
Autoproducer Electricity Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	-1,321.2	1,008.0	0.0	0.0	0.0	0.0	0.0	0.0
Petrochemicals for Raw Materials/Energy	0.0	0.0	-519.9	0.0	0.0	0.0	0.0	0.0
Oil Refineries	0.0	0.0	0.0	-27,236.1	-1,546.4	518.6	2,335.1	951.3
Energy Sector Use	0.0	0.0	-270.0	0.0	0.0	0.0	0.0	0.0
Oil Refineries use	0.0	0.0	-270.0	0.0	0.0	0.0	0.0	0.0
Total Final Consumption (Supply)	0.0	594.0	3,666.3	0.0	0.0	2,101.5	2,377.0	443.1
Total Final Consumption	0.0	594.0	3,666.3	0.0	0.0	2,101.5	2,377.0	443.1
Industry Sector	0.0	594.0	1,969.8	0.0	0.0	76.5	0.0	0.0
Non-specified (Industry)	0.0	0.0	1,969.8	0.0	0.0	76.5	0.0	0.0
Transport Sector	0.0	0.0	0.0	0.0	0.0	0.0	2,377.0	443.1
Other Sectors	0.0	0.0	246.6	0.0	0.0	2,025.0	0.0	0.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	0.0	0.0	246.6	0.0	0.0	2,025.0	0.0	0.0
Non-Energy Use	0.0	0.0	1,449.9	0.0	0.0	0.0	0.0	0.0

(Source) OEP “Annual Energy Report” and the other data gathered by OEP

Table 7.2.1 Brief Summery of Energy Balance Table (1997,Total)

(continued from the previous page)

(Unit; KTOE)

Item	Kero	Diesel	Res_FO	Lub	Bitu	Hydro	Elec	Total
Indigenous Production	0.0	0.0	0.0	0.0	0.0	1,051.1	0.0	54,951.0
Partners Share	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-18,345.8
From Partners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9,467.1
Import	0.0	1,021.2	0.0	47.6	0.0	0.0	0.0	3,283.6
Export	0.0	0.0	-1,899.3	0.0	-0.3	0.0	0.0	-9,755.0
International Marine Bunkers/Aviation	0.0	-251.6	-2,023.7	-0.1	0.0	0.0	0.0	-2,673.0
Stock Changes	-34.8	10.7	25.3	0.0	0.0	0.0	0.0	-267.3
Total Primary Energy Supply	-34.8	780.3	-3,897.7	47.5	-0.3	1,051.1	0.0	36,660.7
Transformation Sector	1,250.0	6,339.1	8,925.9	237.2	784.4	-1,051.1	5,360.9	-7,488.7
Public Electricity Plants	0.0	-221.7	-3,986.2	-11.7	0.0	-1,051.1	5,360.9	-7,137.9
Autoproducer Electricity Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-313.2
Petrochemicals for Raw Materials/Energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-519.9
Oil Refineries	1,250.0	6,560.8	12,912.0	248.8	784.4	0.0	0.0	482.4
Energy Sector Use	0.0	-465.8	-577.4	-6.8	0.0	0.0	-193.1	-1,513.1
Oil Refineries use	0.0	-465.8	-577.4	-6.8	0.0	0.0	0.0	-1,320.0
Total Final Consumption (Supply)	1,258.7	6,563.4	4,505.2	305.2	753.3	0.0	4,556.0	27,538.9
Total Final Consumption	1,258.7	6,563.4	4,505.2	305.2	753.3	0.0	4,556.0	27,538.9
Industry Sector	3.3	2,215.1	3,681.9	90.4	753.3	0.0	1,898.8	11,606.0
Non-specified (Industry)	3.3	2,215.1	3,375.8	90.4	753.3	0.0	1,898.8	10,705.8
Transport Sector	0.0	4,342.9	823.3	174.0	0.0	0.0	0.0	8,236.0
Other Sectors	1,255.4	5.3	0.0	40.8	0.0	0.0	2,657.2	6,247.1
Agriculture	88.0	5.3	0.0	40.8	0.0	0.0	183.3	317.4
Commercial	0.0	0.0	0.0	0.0	0.0	0.0	161.9	161.9
Residential	1,167.5	0.0	0.0	0.0	0.0	0.0	1,598.6	5,041.0
Non-Energy Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,449.9

(Source) OEP "Annual Energy Report" and the other data gathered by OEP

The above table is one of the sheets in "Energy Balance Table" showing the energy balance of 1997. In this file, we have more than 28 sheets for each energy source and summery sheet, which is more detailed than this brief sheet.

7.2.4 Emission Factors of GHGs estimated by this Study

IPCC shows averaged international emission factors of CO_2, expressed in TC/TJ. IPCC also shows the net calorific value of each energy source; TJ/T. T-CO_2/T is obtained from the calculation of (TC/TJ * TJ/T * (44/12) / 1000). This number is the amount of CO_2 emission per energy, expressed in natural ton. By adjusting each energy source with the net calorific value, which is the Egyptian original number, it is easy to obtain the Egyptian original emission factors expressed in T-CO_2/TOE.

In this "Environmental Analysis Model", TC/TJ is used as the emission factors according to IPCC guidelines so that this numbers could be obtained from calculation of (T-CO_2/T * (12/44) / 41.868 * 1000) (See Table 5.1.2). The difference between IPCC averaged emission factors and the Egyptian original emission factors is small, as the Egyptian numbers are smaller than the IPCC numbers due to the differences between the net calorific values of each energy source.

Table 7.2.2 Emission Factor of CO_2

	IPCC Data			Egyptian data			
	TC/TJ	TJ/T	T-CO_2/T	TOE/T	T-CO_2/TOE	T-C/TOE	T-C/TJ
Coke Oven Coke	29.50	29.31	3.1701	0.7000	4.5287	1.2351	29.5
Natural Gas	15.30	46.55	2.6115	1.1110	2.3506	0.6411	15.3
Crude Oil	20.00	41.09	3.0135	0.9950	3.0286	0.8260	19.7
Liquefied Petroleum Gases	17.20	47.31	2.9837	1.1250	2.6522	0.7233	17.3
Natural Gas Liquids	17.20	46.18	2.9124	1.1030	2.6405	0.7201	17.2
Naphtha	20.00	45.01	3.3007	1.1030	2.9925	0.8161	19.5
Motor Gasoline	18.90	44.80	3.1046	1.1030	2.8147	0.7677	18.3
Kerosene type Jet Fuel	19.50	44.59	3.1882	1.0860	2.9357	0.8006	19.1
Kerosene	19.60	44.75	3.2160	1.0860	2.9614	0.8076	19.3
Gas/Diesel Oil	20.20	43.33	3.2093	1.0660	3.0106	0.8211	19.6
Residual Fuel Oil	21.10	40.19	3.1094	0.9720	3.1989	0.8724	20.8
Lubricants	20.00	40.19	2.9473	0.9720	3.0322	0.8270	19.8
Refinery Gas	18.20	48.15	3.2132	1.1250	2.8562	0.7790	18.6
Petroleum Coke	27.50	31.00	3.1258	0.7400	4.2241	1.1520	27.5
Non-specified Petroleum Products	20.00	40.19	2.9473	0.9720	3.0322	0.8270	19.8

(Note) TC/TJ and TJ/T in IPCC Data are the numbers estimated by IPCC, and we can find these data in IPCC guideline. T-CO_2/T in IPCC Data is obtained from calculating the following calculation : (TC/TJ * TJ/T * (44/12)/1000). In order to obtain the Egyptian original emission factor, we must adjust IPCC numbers by the Egyptian original net calorific value of each energy source.

TOE/T in Egyptian Data is the net calorific value in Egypt. T-CO_2/TOE is calculated from the following calculation: ((T-CO_2/T) / (TOE/T)) and T-C/TOE from (T-CO_2/TOE * (12/44)). Finally, T-C/TJ is calculated from the following calculation : (T-C/TOE / 41.868 * 1000), in which 41.868 is the conversion factor from KTOE to TJ.

(Source) "IPCC Guidelines for national Greenhouse Gas Inventories, 1996" and OEP "Annual Energy Report"

For non-CO_2 emission factors excluding SO_2 and NO_x, the IPCC emission factors are used due to the lack of the sufficient information about non-CO_2 conditions. But for SO_2 and NO_x, the IPCC emission factors are checked using the emission factors estimated by the Japanese study mentioned earlier. For SO_2, the estimation is the sulfur content in each energy source in Egypt referring to the Japanese study and the emission factors obtained under the conditions that most of the sulfur content are changed to SO_2 and are released to the atmosphere. Therefore, this number is the Egyptian original emission factor (See Table 7.2.3). For NO_x, after comparing IPCC method and the Japanese study, we adopted the Japanese study method because the Japanese method was more detailed than IPCC and gave us detailed data for estimation of NO_x effect (See Table 7.2.4).

For CH_4, N_2O, CO and NMVOC emission factors, IPCC shows each emission factor by energy sectors and energy sources, with three big items--Solid, Gaseous, Liquid (See Table

7.2.5).

Table 7.2.3 Emission Factor of SO_2

	Sulphur content of fuel (%)	Sulphur retention in ash (%)	Abatement Efficiency (%)	Calorific Value (TJ/kt)	SO2 Emission factor (T/TJ)
Coke Oven Coke	1.0000	20		29.3	0.5459
Natural Gas	0.0100	0		46.5	0.0043
LPG	0.1200	0		47.1	0.0510
Gasoline	0.0400	0		46.2	0.0173
Jet Kerosene	0.1600	0		45.5	0.0704
Kerosene	0.0400	0		45.5	0.0176
Diesel Oil	0.1600	0		44.6	0.0717
Heavy Fuel Oil	1.4000	0		40.7	0.6880
Lub	0.1000	0		40.7	0.0491
P-non	1.0000	15		40.7	0.4177

(Note) SO_2 emission factor is obtained from the following calculating :

EF = 2 * ((Sulfur content /100)/ Calorific Value * 1000) * ((100 - sulfur retention)/100) *((100 - Abatement Efficiency)/100). Coefficient 2 means the converter from S to SO_2.

Sulfur content is estimated according to the Japanese study. Calorific Value is the Egyptian number. Sulfur retention in ash and Abatement Efficiency comes from IPCC estimate.

Table 7.2.4 Emission Factor of NO_x

	COC T/TJ	NG T/TJ	LPG T/TJ	Gasoline T/TJ	Jet T/TJ	kerosene T/TJ	diesel T/TJ	HFOil T/TJ	Lub T/TJ	Non-Oil T/TJ
Industry Sector	0.14068	0.05350	0.05584			0.16407	0.21554	0.14350	0.14350	0.14350
Transport Sector				0.68644	0.23093	0.60261	0.61392	0.67329		0.14350
other sector		0.03750	0.01868			0.05476	0.07192	0.04793	0.04792	
Electricity Sector		0.10509					0.61325	0.24573	0.24573	
Energy Sector		0.10509					0.61325	0.24573	0.24573	

(Source) Calculated according to the Egyptian data and STA, Japan "NISTEP REPORT No.21"

Table 7.2.5 Emission Factor of Non-CO_2

(Unit: Kg/TJ)

<table>
<tr><th>CH_4 Emission Factor</th><th>Total Solid Fossil</th><th>TotalGaseous Fossil</th><th colspan="2">Total Liquid Fossil</th></tr>
<tr><td>Industry Sector</td><td>10.0</td><td>5.0</td><td colspan="2">2.0</td></tr>
<tr><td rowspan="2">Transport Sector</td><td rowspan="2">10.0</td><td rowspan="2">50.0</td><td>Gasoline</td><td>Diesel</td></tr>
<tr><td>20.0</td><td>5.0</td></tr>
<tr><td>Other Sector</td><td>300.0</td><td>5.0</td><td colspan="2">10.0</td></tr>
<tr><td>Electricity Sector</td><td>1.0</td><td>1.0</td><td colspan="2">3.0</td></tr>
<tr><td>Energy Sector (Refinery)</td><td>1.0</td><td>1.0</td><td colspan="2">3.0</td></tr>
</table>

N_2O Emission Factor	Total Solid Fossil	TotalGaseous Fossil	Total Liquid Fossil	
Industry Sector	1.4	0.1	0.6	
Transport Sector			Gasoline	Diesel
	1.4	0.1	0.6	0.6
Other Sector	1.4	0.1	0.6	
Electricity Sector	1.4	0.1	0.6	
Energy Sector (Refinery)	1.4	0.1	0.6	

NO_x Emission Factor	Total Solid Fossil	TotalGaseous Fossil	Total Liquid Fossil	
Industry Sector	300.0	150.0	200.0	
Transport Sector			Gasoline	Diesel
	300.0	600.0	600.0	800.0
Other Sector	100.0	50.0	100.0	
Electricity Sector	300.0	150.0	200.0	
Energy Sector (Refinery)	300.0	150.0	200.0	

CO Emission Factor	Total Solid Fossil	TotalGaseous Fossil	Total Liquid Fossil	
Industry Sector	150.0	30.0	10.0	
Transport Sector			Gasoline	Diesel
	150.0	400.0	8000.0	1000.0
Other Sector	2000.0	50.0	20.0	
Electricity Sector	20.0	20.0	15.0	
Energy Sector (Refinery)	20.0	20.0	15.0	

NMVOC Emission Factor	Total Solid Fossil	TotalGaseous Fossil	Total Liquid Fossil	
Industry Sector	20.0	5.0	0.0	
Transport Sector			Gasoline	Diesel
	20.0	5.0	1500.0	200.0
Other Sector	200.0	5.0	5.0	
Electricity Sector	5.0	5.0	0.0	
Energy Sector (Refinery)	5.0	5.0	0.0	

(Source) “IPCC Guidelines for national Greenhouse Gas Inventories, 1996

7.2.5 CO_2 and CH_4 Emissions from Industrial Process and Wastes

Figure7.2.6 shows the estimation of CO_2 emissions from industrial process and CH_4 emissions from industrial wastewater and sludge and solid waste disposal sites, in which CH_4 emissions are estimated by the use of IPCC method. Because it was difficult to get the time series data for the same period of energy consumption, the estimation of CO_2 emissions was based on the most recent annual data and CH_4 emissions of the short-term database.

Cement industry and Iron & Steel industry are using limestone ($CaCO_3$) for producing cement (CaO) and removing impurities in the sintering and blast furnace. According to the Japanese study titled "Study on CO_2 Emission", which was published by Environmental Agency of Japan in May 1992, CO_2 emission from cement production is 463.7 CO_2-Kg/cement production T (See Table 5.1.6). And CO_2 emission from $CaCO_3$ utilized in Iron & Steel industry is 440 CO_2-Kg/raw-steel-production T (See Table 7.2.6).

Cement production in FY 1998/99 in Egypt is 22.90Mt with an estimated CO_2 emission of 10.62Mt. Raw steel production in FY 1998/99 is 5.15Mt with the CO_2 emission of 0.31Mt on the presumption that the Egyptian iron industry consumes the same amount of CaCO3 as the Japanese iron industry (0.138 * T-CaCO3/T-raw steel production). Total CO_2 emission from industrial process is 10.93Mt (See Table 7.2.7).

Table 7.2.6 CO_2 Emission Factor of Limestone ($CaCO_3$)

	Cement Production	Lime Stone Consumption	CO_2 Emission	Cabon Emission	CO_2-EF/ Cem Prod	C-EF/ Cem Prod	CO_2-EF/ Lime Cons	C-EF/ Lime Cons
	KT/FY	KT/FY	KT/FY	KT/FY	CO_2-T/T	C-T/T	CO_2-T/T	C-T/T
	A	B	C	D	E	F	E	F
			C=B*CO_2/$CaCO_3$	D=B*C/$CaCO_3$	E=C/A*1000	F=D/A*1000	E=C/B*1000	F=D/B*1000
1980	86,358	107,037	47,096	12,844	0.5454	0.1487	0.4400	0.1200
1981	84,002	100,653	44,287	12,078	0.5272	0.1438	0.4400	0.1200
1982	80,362	96,325	42,383	11,559	0.5274	0.1438	0.4400	0.1200
1983	79,799	95,279	41,923	11,433	0.5254	0.1433	0.4400	0.1200
1984	77,786	91,319	40,180	10,958	0.5166	0.1409	0.4400	0.1200
1985	72,500	83,003	36,521	9,960	0.5037	0.1374	0.4400	0.1200
1986	70,782	76,719	33,756	9,206	0.4769	0.1301	0.4400	0.1200
1987	74,344	78,458	34,522	9,415	0.4643	0.1266	0.4400	0.1200
1988	77,302	81,182	35,720	9,742	0.4621	0.1260	0.4400	0.1200
1989	80,123	84,617	37,231	10,154	0.4647	0.1267	0.4400	0.1200
1990	86,893	91,583	40,297	10,990	0.4637	0.1265	0.4400	0.1200

(Note) CO2/$CaCO_3$ means 44/100, and C/$CaCO_3$ means 12/100

(Source) Environmental Agency, Japan "Study on CO_2 Emission" May, 1992 (Japanese language)

Table 7.2.7 CO_2 Emission from Industrial Process

1999/98	Production T/Year	Emission of CO2 CO2-MT	C CO2-MT
Iron & Steel Industry	5,148,100	0.31	0.09
Cement Industry	22,900,000	10.62	2.90
Total		10.93	2.98

OEP has the calculated CH_4 emissions from the industrial wastewater & sludge and solid waste disposal sites for the last several years. According to OEP data, the amount of CH_4 emissions from industrial wastewater and sludge treatment fluctuated between 80.5 Kt and 100 Kt between 1990/91 and 1995/96. And CH_4 emissions, released from solid waste disposal sites, have increased from 113.02 Kt in 1990/91 to 126.18 Kt in 1995/96 and to 127.70 Kt in 1996/97. Adding these numbers, the total CH_4 emission is 210.18 Kt in 1995/96. This volume of methane can be converted to CO_2 equivalent volume using global warming potential coefficient. The amount of CH_4 emission is equivalent to 4.41 $MtCO_2$ (See table 7.2.8).

These numbers for CO_2 are neither small nor big because the recent CO_2 emissions from fuel combustion are about 80 - 100 Mt, and the amount of CO_2 from industrial process and waste reaches about 15.34 Mt, accounting for 15 - 19 % of the fuel combustion of CO_2.

Table 7.2.8 Methane Emission from Wastes

(Unit: Kt) (Unit: Mt)

	Solid Waste	Industrial Wastewater and Sludge Treatment				CO2
	Diposal Sites	Sub Total	Wastewater	Sludge Treatment	TOTAL	Equivalent
1990/1991	113.02	80.50	32.20	48.30	193.52	4.06
1991/1992	115.62	89.60	36.10	53.50	205.22	4.31
1992/1993	118.28	89.80	36.20	53.60	208.08	4.37
1993/1994	121.00	85.70	34.00	51.70	206.70	4.34
1994/1995	123.78	99.70	39.20	60.50	223.48	4.69
1995/1996	126.18	84.00	33.70	50.30	210.18	4.41
1996/1997	127.70					

(Source) OEP data

7.3 Estimated GHG Emissions and the Implications

7.3.1 Structure of GHG Emissions

In 1998/99, the fossil fuel consumption in Egypt is 1,457,404 TJ, and CO_2 emissions are 103.82 $MtCO_2$, with 103.45 $MtCO_2$ of CO_2 converted from fuel combustion and 0.37 $MtCO_2$ of CO_2 from non-CO_2 emissions (CH_4 and N_2O) . CO_2 converted from non-CO_2 emissions means that the greenhouse gas effect potential of non-CO_2 is estimated as CO_2 emission effect or the amount of CO_2 equivalent for non-CO_2 gases.

The average CO_2 intensity is 71.23 TCO_2/TJ, the largest intensity of which is 74.55 TCO_2/TJ in the Industry Sector and the smallest intensity is 60.10 TCO_2/TJ in the Other Sector. This situation reflects the fact that the share of residual fuel oil, whose CO_2 emission factor is larger than that of any other oil products, is large in the Industrial Sector. In the Other Sector, share of natural gas, whose CO_2 emission factor is the smallest among fossil fuels, is large.

If CO_2 from industrial process (limestone utilization) in 1998/99 and CO_2 converted from CH_4 (originated from the waste treatment and disposal in 1995/96) are considered for the amount of CO_2 emission, the total CO_2 emission reaches about 118MtCO_2, and CO_2 intensity in the Industry becomes bigger than before (See Table 7.3.1).

Table 7.3.1 Fossil Fuel Consumption and CO_2 Emissions in 1998/99

1998	Energy Consumption	CO_2 Emission	from Fuel	from Non-CO_2	CO_2 Intensity per Energy Consumption without other CO_2	CO_2 Intensity per Energy Consumption with other CO_2
	(TJ)	(MTCO_2)	(MTCO_2)	(MTCO_2)	(TCO_2/TJ)	(TCO_2/TJ)
Industry	356,923	26.61	26.52	0.08	74.55	83.39
Transportation	381,551	26.83	26.68	0.15	70.33	70.33
OtherSector	158,591	10.48	10.42	0.06	66.10	69.13
Electricity	503,429	35.73	35.66	0.06	70.97	70.97
Energy Sector	56,910	4.17	4.15	0.01	73.20	73.20
Total	1,457,404	103.82	103.45	0.37	71.23	83.11

(Note) Other CO_2 means the other kinds of CO_2 and is the CO_2 emissions from industrial process (1998/99), converted from CH_4 from the waste treatment and disposal (1995/96). It is assumed to be the same level as 1998/99.

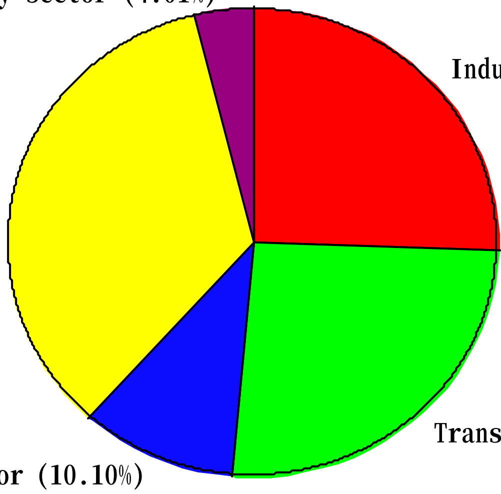
The Electricity Sector is the biggest CO_2 emission sector, whose share is 34.41% of the total CO_2 emission from fossil fuel combustion, followed by 25. 85% of the Transport Sector. The share of the Industrial Sector is the third, with 25.63%, which is almost the same share as the Transport Sector (See Figure 7.3.1).

But the other kinds of CO_2, which are CO_2 from industrial process and CH_4 from waste, added to the CO_2 emissions, its situation changes. The Industrial Sector becomes the largest CO_2 emission sector (31.50%), followed by the Electricity Sector (29.98%). This change is a result of taking other kinds of CO_2, whose share is large enough to give an influence to the structure of CO_2 emissions in Egypt, into the consideration . In case of estimation of CO_2 emissions from industrial process, we used the efficient emission factors from the Japanese study that were obtained from the Japanese Cement and Iron industry. So, if we could obtain Egyptian original emission factors of CO_2, the weight of CO_2 emissions from industrial process would be larger than this estimation (See Figure 7.3.1).

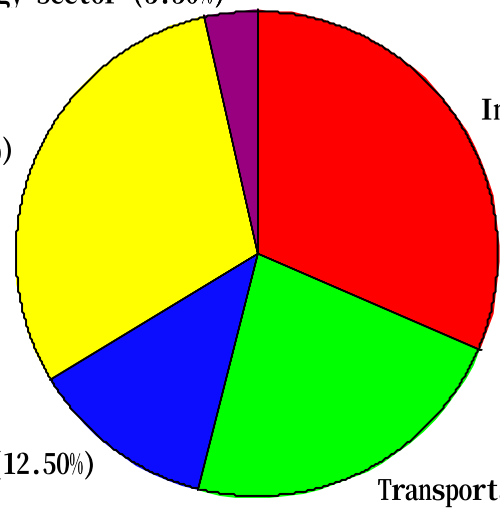
From the CO_2 intensity and share, the countermeasure to improve the CO_2 intensity in the Industrial Sector, including fuel efficiency and process improvement, is one of the very important energy and environmental policy targets in Egypt.

Figure 7.3.1 Structure of CO_2 Emission by Sector in 1998/99

(a) Structure of CO_2 Emissions by Sector excluding the other kinds of CO_2



(b) Structure of CO_2 Emissions by Sector including the other kinds of CO_2



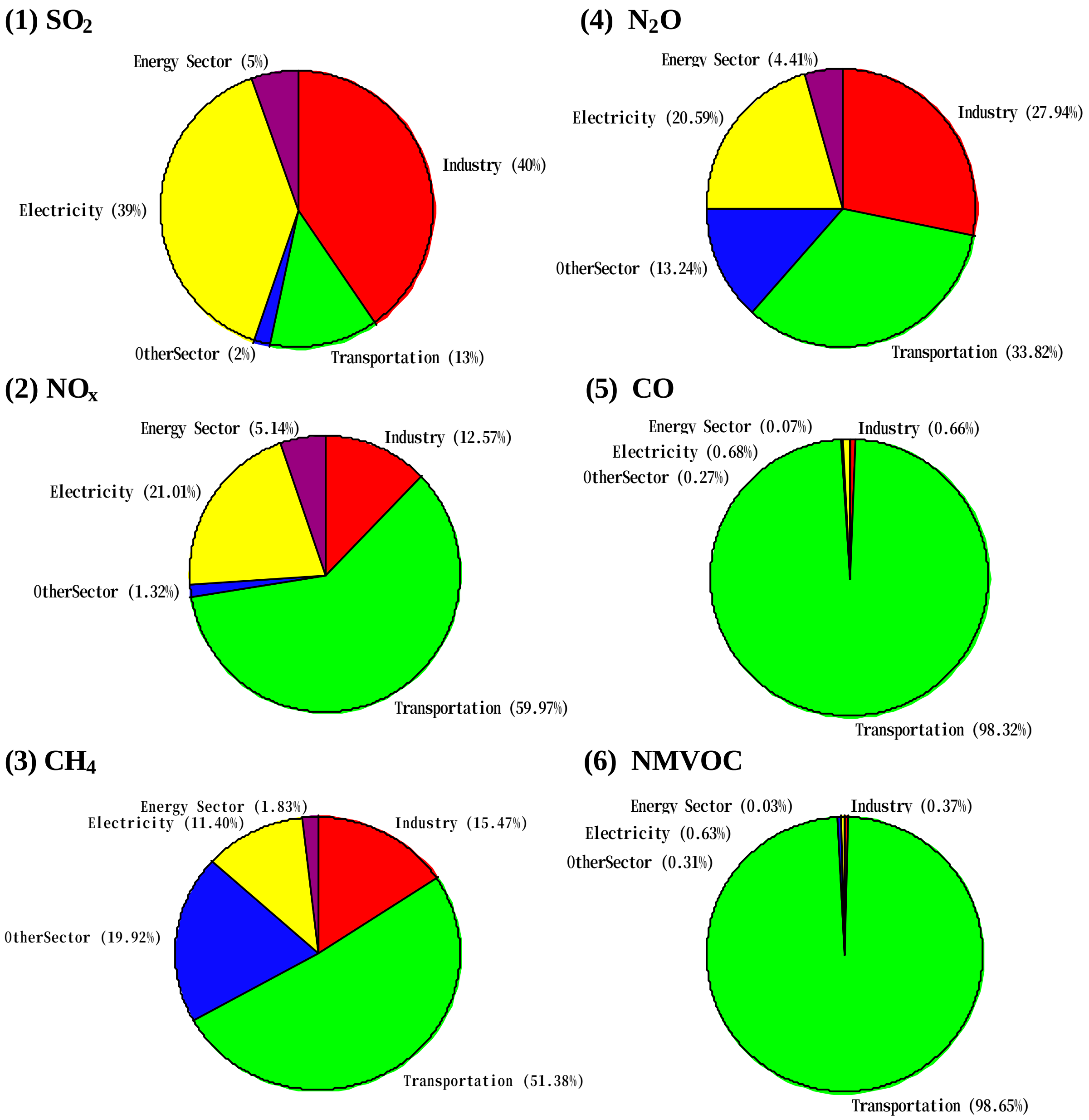
(Note) The other kinds of CO_2 is CO_2 emissions from industrial process (1998/99) and converted from CH_4 from the waste treatment and disposal (1995/96). It is assumed to be the same level as 1998/99.

Non-CO_2 emissions are: SO_2, 313 Kt(SO_2); NO_x, 383 Kt(NO_x); CH_4, 7.63 Kt(CH_4); N_2O, 0.68 Kt(N_2O); CO, 1,343 Kt(CO); and NMVOC, 254 Kt(NMVOC). For SO_2, the Industrial Sector and the Electricity Sector are two of the biggest emission sectors. For NO_x, CH_4, CO and NMVOC, the Transport Sector is the biggest emission sector. The Other Sector and the Energy Sector are playing a small role in the emissions of non-CO_2 (See Table 7.3.2).

Table 7.3.2 Non-CO_2 Emissions in 1998/99

1998	SO_2 Emission ($KTSO_2$)	NO_x Emission ($KTNO_x$)	CH_4 Emission ($KTCH_4$)	N_2O Emission (KTN_2O)	CO Emission (KTCO)	NMVOC Emission (KTNMVOC)
Industry	125.92	48.15	1.18	0.19	8.87	0.95
Transportation	41.39	229.75	3.92	0.23	1320.88	250.76
OtherSector	5.84	5.04	1.52	0.09	3.57	0.79
Electricity	123.01	80.50	0.87	0.14	9.16	1.61
Energy Sector	17.20	19.70	0.14	0.03	0.92	0.07
Total	313.35	383.14	7.63	0.68	1,343.40	254.17

Figure 7.3.2 Structure of Non-CO_2 Emissions by Sector in 1998/99



Non-CO_2 emission intensities per energy consumption are shown in Table 7.3.3. For SO_2, the biggest intensity sector is the Industry Sector. The second biggest sector is not the Electricity Sector but the Energy Sector, due to the difference between energy consumption structures of the Electricity Sector and the Energy Sector. For NO_x, CH_4, N_2O, CO and NMVOC, the biggest intensity sector is the Transport Sector. The second biggest sector differs for different non-CO_2 emission gases. For NO_x emission, for example, the second biggest intensity sector is the Energy Sector, and for CH_4, it is the Other Sector. For N_2O, it is the Other Sector while it is the Industry Sector for CO. The second biggest intensity sector for NMVOC is the Other Sector.

Table 7.3.3 Non-CO_2 Emission Intensity per Energy Consumption in 1998/99

	SO_2 Emission ($KgSO_2/TJ$)	NO_x Emission ($KgNO_x/TJ$)	CH_4 Emission ($KgCH_4/TJ$)	N_2O Emission (KgN_2O/TJ)	CO Emission (KgCO/TJ)	NMVOC Emission (KgNMVOC/TJ)
Industry	352.8	134.9	3.31	0.53	24.9	2.7
Transportation	108.5	602.2	10.28	0.60	3,461.9	657.2
OtherSector	36.8	31.8	9.58	0.56	22.5	5.0
Electricity	244.3	159.9	1.72	0.28	18.2	3.2
Energy Sector	302.3	346.1	2.53	0.48	16.2	1.2
Total	215.0	262.9	5.24	0.46	921.8	174.4

Energy and Environmental Policy must include SO_2 emission regulation policy, especially in the Industry Sector, and NO_x emission regulation policy, especially in the Transport Sector.

7.3.2 Historical Analysis of GHG Emissions

Between 1981/82 and 1998/99, the fossil energy consumption in Egypt increased by an annual growth rate of 4.89%, and CO_2 emission from fossil energy consumption increased by an annual growth rate of 4.51%. So the elasticity value of CO_2 to fossil energy consumption is 0.92. The reason why the elasticity value is under 1.00 is the structural change of fossil energy consumption or the change from energy sources with high intensity of CO_2 to other energy sources with comparatively low intensity of CO_2 (See Table 7.3.4).

Table 7.3.5 shows that the share of liquid fossil fuel was 89.0% in 1981/82 and the share of gaseous fossil fuel was only 8.2%. In 1998/99, the share of gaseous fossil fuel, whose CO_2 emission factor was the lowest among fossil fuels, increased to 38.9%, and the share of liquid fossil fuel decreased to 60.0%.

In the Industrial Sector, there is a structural change from liquid fossil fuel to gaseous fuel and electricity, CO_2 emission factor of which is comparatively lower than that of liquid fossil fuel. The situations are observed in the Other Sector as well. These two sectors enjoy the reduction of CO_2 intensity as result of structural change in energy consumption.

For the Transport Sector, such change has not happened. But in this sector, there happens to be another kind of structural change in liquid fossil fuel, from gasoline to diesel, whose CO_2 emission factor is bigger than that of gasoline. Table 7.3.7 shows that the share of gasoline consumption was 37.1% and the share of diesel consumption was 46.3% in 1981/82. In 1998/99, the share of gasoline decreased to 26.7%, and that of diesel increased to 57.5%. The share of residual fuel oil also increased, from 2.5% to 7.9%. CO_2 emission factor of residential fuel oil is bigger than that of gasoline and diesel. The structural changes of energy consumption increased the amount of CO_2 emissions more than the growth of energy consumption in this period.

For the Electricity Sector and the Energy Sector, there happens to be a structural change from liquid fossil fuel to gaseous fossil fuel rapidly, especially in the field of generation, where the share of liquid fuel was 79.5%, up from 20.5% in 1981/82. In 1998/99, the situation was reversed. The share of gaseous fuel was 63.8%, and a share of liquid fuel was 36.2% (See Table 7.3.8). In the Energy Sector, the same phenomenon is recognized although the scale of change was smaller than the scale in the Electricity Sector. Thus, these transformation sectors have potentials to reduce CO_2 emission, compared to the sectors that such structural changes have not happened.

For non-CO_2 emissions between 1981/82 and 1991/92, the changing tendencies of non-CO_2 emissions were almost identical with one another. After 1991/92, we can see that there are some differences for each non-CO_2 emission. The amount of SO_2 emissions was the lowest due to the fuel conversion from liquid fuel to gaseous fuel, because the emission factors of gaseous fuel were very small.

Table 7.3.4 Comparison of Energy Consumption and CO_2 Emissions

	Fossil Fuel Consumption (TJ)	CO_2 Emision ($MtCO_2$)	Fossil Fuel Consumption	CO_2 Emision
			1981/82=100	
1981/82	647,677	46.4	100.0	100.0
1982/83	732,270	52.4	113.1	112.9
1983/84	816,164	58.1	126.0	125.2
1984/85	883,495	62.6	136.4	134.9
1985/86	903,869	63.2	139.6	136.2
1986/87	969,229	67.8	149.6	146.0
1987/88	1,025,829	71.4	158.4	153.9
1988/89	1,027,561	71.3	158.7	153.7
1989/90	1,080,036	74.7	166.8	161.0
1990/91	1,114,327	76.8	172.0	165.6
1991/92	1,116,497	76.9	172.4	165.7
1992/93	1,111,391	75.6	171.6	162.9
1993/94	1,107,880	74.8	171.1	161.2
1994/95	1,162,162	78.2	179.4	168.4
1995/96	1,235,918	83.3	190.8	179.4
1996/97	1,288,791	87.0	199.0	187.4
1997/98	1,400,527	94.7	216.2	204.1
1998/99	1,457,404	98.2	225.0	211.6
1999/00	1,542,000	103.1	238.1	222.2
2000/01	1,639,367	109.3	253.1	235.4
2001/02	1,746,421	116.0	269.6	250.0
2002/03	1,864,156	123.5	287.8	266.0
2003/04	1,994,121	131.7	307.9	283.7
2004/05	2,137,586	140.7	330.0	303.2
2005/06	2,296,045	150.7	354.5	324.8
Average Growth Rates				
(1998/99)/(1981/82)	4.89	4.51	4.89	4.51
(2005/06)/(1998/99)	6.71	6.31	6.71	6.31
(2005/06)/(1981/82)	5.41	5.03	5.41	5.03

Table 7.3.5 Energy Consumption by Energy Source and the Share

	Liquid	Solid	Gaseous	Total	Liquid	Solid	Gaseous	Total
	(TJ)				(Share; %)			
1981/82	576,253	18,071	53,353	647,677	89.0	2.8	8.2	100.0
1982/83	649,602	18,569	64,098	732,270	88.7	2.5	8.8	100.0
1983/84	715,538	17,596	83,030	816,164	87.7	2.2	10.2	100.0
1984/85	763,639	17,848	102,008	883,495	86.4	2.0	11.5	100.0
1985/86	735,941	18,754	149,175	903,869	81.4	2.1	16.5	100.0
1986/87	786,467	19,120	163,641	969,229	81.1	2.0	16.9	100.0
1987/88	812,409	20,846	192,574	1,025,829	79.2	2.0	18.8	100.0
1988/89	797,842	22,819	206,900	1,027,561	77.6	2.2	20.1	100.0
1989/90	828,275	22,719	229,042	1,080,036	76.7	2.1	21.2	100.0
1990/91	841,680	21,324	251,322	1,114,327	75.5	1.9	22.6	100.0
1991/92	826,235	25,310	264,951	1,116,497	74.0	2.3	23.7	100.0
1992/93	770,646	25,928	314,816	1,111,391	69.3	2.3	28.3	100.0
1993/94	730,883	29,853	347,144	1,107,880	66.0	2.7	31.3	100.0
1994/95	766,797	25,987	369,378	1,162,162	66.0	2.2	31.8	100.0
1995/96	838,784	21,383	375,751	1,235,918	67.9	1.7	30.4	100.0
1996/97	864,269	30,073	394,450	1,288,791	67.1	2.3	30.6	100.0
1997/98	968,926	24,870	406,730	1,400,527	69.2	1.8	29.0	100.0
1998/99	995,475	25,197	436,733	1,457,404	68.3	1.7	30.0	100.0
1999/00	1,014,699	25,524	501,777	1,542,000	65.8	1.7	32.5	100.0
2000/01	1,061,956	25,675	551,736	1,639,367	64.8	1.6	33.7	100.0
2001/02	1,113,477	25,828	607,116	1,746,421	63.8	1.5	34.8	100.0
2002/03	1,170,164	25,984	668,008	1,864,156	62.8	1.4	35.8	100.0
2003/04	1,232,447	26,143	735,532	1,994,121	61.8	1.3	36.9	100.0
2004/05	1,301,096	26,304	810,187	2,137,586	60.9	1.2	37.9	100.0
2005/06	1,376,992	26,467	892,586	2,296,045	60.0	1.2	38.9	100.0

Table 7.3.6 Share of Energy Sources by Sector

	Indusry Sector					Transport Sector		Other Sector			
	Liquid	Solid	Gaseous	Electricity	Energy	Liquid	Energy	Liquid	Gaseous	Electricity	Energy
1981/82	51.7	6.2	7.0	30.9	4.2	94.2	5.8	56.7	0.1	39.7	3.5
1982/83	53.1	5.6	5.1	31.5	4.7	93.6	6.4	52.7	0.2	43.5	3.6
1983/84	51.3	4.9	5.9	33.5	4.4	93.9	6.1	49.4	0.4	47.0	3.3
1984/85	51.3	4.6	6.6	33.0	4.4	93.9	6.1	47.9	0.5	48.4	3.2
1985/86	48.3	5.0	7.5	34.5	4.7	93.5	6.5	47.9	0.6	48.1	3.4
1986/87	49.0	4.6	8.4	33.9	4.2	94.2	5.8	46.8	0.7	49.7	2.9
1987/88	46.2	4.7	10.0	35.2	3.9	94.4	5.6	45.0	0.7	51.6	2.7
1988/89	44.1	5.2	10.3	36.4	4.0	94.2	5.8	44.9	0.7	51.5	2.8
1989/90	45.3	4.8	11.8	34.1	4.0	94.4	5.6	44.4	0.8	52.1	2.7
1990/91	46.0	4.3	11.2	34.5	4.0	94.5	5.5	41.9	0.8	54.7	2.5
1991/92	44.7	5.1	11.3	35.0	3.9	94.4	5.6	38.8	1.0	57.8	2.4
1992/93	42.7	5.4	11.9	35.7	4.3	93.8	6.2	38.0	1.1	58.3	2.6
1993/94	42.1	6.1	12.8	34.5	4.5	93.7	6.3	36.7	1.2	59.5	2.6
1994/95	43.6	5.1	13.2	33.4	4.6	93.6	6.4	34.9	1.5	61.1	2.5
1995/96	45.7	4.0	12.7	33.1	4.5	93.9	6.1	34.1	1.8	61.8	2.4
1996/97	43.7	5.4	13.0	33.6	4.3	94.0	6.0	33.3	2.0	62.5	2.3
1997/98	44.3	4.2	13.8	33.5	4.2	94.2	5.8	31.8	2.4	63.8	2.1
1998/99	41.6	4.3	15.2	34.9	4.0	94.1	5.9	31.0	2.9	64.0	2.1
1999/00	41.3	4.1	15.8	34.8	4.0	94.5	5.5	29.4	2.9	65.7	1.9
2000/01	41.0	3.9	16.5	34.6	3.9	94.6	5.4	27.8	3.0	67.5	1.8
2001/02	40.7	3.7	17.3	34.5	3.9	94.8	5.2	26.3	3.0	69.1	1.6
2002/03	40.4	3.5	18.2	34.2	3.8	95.0	5.0	24.9	3.0	70.7	1.5
2003/04	40.1	3.2	19.0	34.0	3.6	95.2	4.8	23.5	2.9	72.2	1.4
2004/05	39.8	3.0	19.9	33.8	3.5	95.4	4.6	22.3	2.9	73.6	1.2
2005/06	39.6	2.8	20.7	33.5	3.3	95.5	4.5	21.1	2.8	75.0	1.1

Table 7.3.7 Share of Energy Sources in Transportation Sector

	Gasoline	Jet	Diesel	Residual Fuel Oil	Lubricants	Others	Total
1981/82	37.1	9.1	46.3	2.5	2.3	2.7	100.0
1982/83	39.9	8.5	44.6	2.0	2.4	2.7	100.0
1983/84	39.8	9.2	44.6	1.8	2.4	2.2	100.0
1984/85	40.7	8.7	44.4	2.0	2.4	1.7	100.0
1985/86	40.8	8.2	45.1	2.5	2.3	1.1	100.0
1986/87	41.5	7.2	45.5	2.2	2.4	1.2	100.0
1987/88	40.6	7.7	45.9	2.4	2.4	1.0	100.0
1988/89	40.5	7.5	46.3	2.2	2.5	1.0	100.0
1989/90	39.4	9.2	45.5	2.7	2.5	0.8	100.0
1990/91	37.4	7.8	49.0	2.4	2.5	1.0	100.0
1991/92	36.3	7.9	50.0	2.4	2.3	1.1	100.0
1992/93	32.2	7.9	46.0	10.8	2.2	1.1	100.0
1993/94	31.9	7.2	48.3	9.5	2.3	0.9	100.0
1994/95	31.6	6.1	49.5	9.4	2.2	1.2	100.0
1995/96	29.6	6.6	50.8	9.8	2.1	1.1	100.0
1996/97	29.5	6.0	52.5	9.0	2.1	0.9	100.0
1997/98	28.9	5.4	52.7	10.0	2.1	0.9	100.0
1998/99	26.7	5.0	57.5	7.9	2.0	0.9	100.0
1999/00	25.9	4.9	58.5	7.8	2.0	1.0	100.0
2000/01	25.4	4.8	59.2	7.6	2.1	1.0	100.0
2001/02	24.9	4.6	60.0	7.3	2.2	0.9	100.0
2002/03	24.3	4.5	60.9	7.1	2.3	0.9	100.0
2003/04	23.7	4.3	61.8	6.9	2.4	0.9	100.0
2004/05	23.0	4.2	62.8	6.7	2.5	0.9	100.0
2005/06	22.2	4.0	63.8	6.4	2.6	0.9	100.0

Table 7.3.8 Share of Energy Sector in Transformation Sector

	Electricity Sector		Energy Sector	
	Liquid	Gaseous	Liquid	Gaseous
1981/82	79.5	20.5	100.0	0.0
1982/83	76.2	23.8	100.0	0.0
1983/84	74.2	25.8	100.0	0.0
1984/85	70.9	29.1	100.0	0.0
1985/86	55.3	44.7	100.0	0.0
1986/87	56.9	43.1	100.0	0.0
1987/88	55.4	44.6	96.6	3.4
1988/89	52.9	47.1	92.9	7.1
1989/90	50.4	49.6	92.5	7.5
1990/91	47.4	52.6	87.9	12.1
1991/92	46.9	53.1	83.2	16.8
1992/93	33.5	66.5	84.6	15.4
1993/94	25.3	74.7	84.3	15.7
1994/95	25.0	75.0	84.5	15.5
1995/96	27.9	72.1	86.4	13.6
1996/97	29.4	70.6	84.3	15.7
1997/98	36.9	63.1	79.5	20.5
1998/99	36.2	63.8	76.7	23.3
1999/00	31.6	68.4	73.8	26.2
2000/01	31.1	68.9	71.1	28.9
2001/02	30.7	69.3	68.5	31.5
2002/03	30.3	69.7	65.9	34.1
2003/04	30.0	70.0	63.4	36.6
2004/05	29.6	70.4	61.0	39.0
2005/06	29.3	70.7	58.6	41.4

On the other hand, the growth curve of CO and NMVOC was higher than that of others because these emissions were generated almost exclusively in the Transport Sector. The second group of the growth curve was NO_x and CH_4, from the large share of the Transport Sector, with 60% for NO_x and 56% for CH_4 in 1998/99.

The amount of SO_2 emissions has increased by 2.83% annually between 1981/82 and 1998/99. The shares of the Industry Sector and the Energy Sector decreased while the shares of the Transport Sector and the Electricity Sector increased. The share of the Electricity Sector decreased tentatively in the early 1990s due to the fuel conversion to gaseous fuel. The amount of NO_x emissions has increased by 4.39% annually during the same period. In this case, only the share of the Transport Sector increased. For CH_4, the amount of CH_4 increased by 4.23% annually during the same period. The shares of the Transport Sector and the Electricity Sector increased, but the increase of the Electricity Sector was very small. For N_2O, the amount of N_2O increased by 3.51% annually. The tendency of structural changes was almost the same as the other GHG emission field, but the scale in the Transport Sector was not so large. In the case of CO and NMVOC emissions, the amount of each gas emissions has reflected the energy consumption in the Transport Sector, whose shares were more than 98% of the total emission.

The policy on the Transport Sector to improve energy efficiency and/or set the emission standard is very important in reducing the non-CO_2 emissions because the non-CO_2 emissions are intimately related to the energy consumption in the Transport Sector.

Figure 7.3.3 Index of Non-CO_2 Emissions (1981/82 = 100)

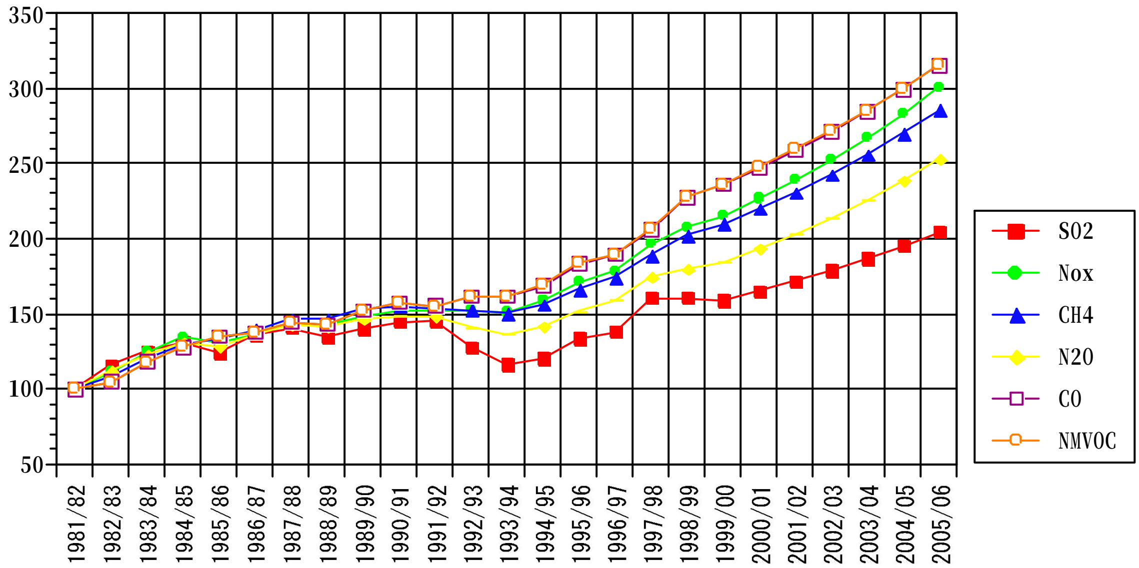


Table 7.3.9 The Growth Rate in each Non-CO_2 Emission

	SO_2	NO_x	CH_4	N_2O	CO	NMVOC
(1998/99)/(1981/82)	2.83	4.39	4.23	3.51	4.95	4.96
(2005/06)/(1998/99)	3.50	5.43	5.06	5.02	4.77	4.78
(2005/06)/(1981/82)	3.02	4.69	4.47	3.94	4.90	4.91

Table 7.3.10 Share by Energy Sector in each Non-CO_2 Emission (1)

(SO_2) (NO_x)

	SO_2 Industry	SO_2 Transport	SO_2 Other	SO_2 Electricy	SO_2 Energy	SO_2 Total	NO_x Industry	NO_x Transport	NO_x Other	NO_x Electricy	NO_x Energy	NO_x Total
	(Share, %)					($KtSO_2$)	(Share, %)					($KtNO_x$)
1981/82	48.2	6.5	1.3	35.8	8.1	195.07	14.8	52.8	2.6	24.7	5.1	184.57
1982/83	47.5	5.5	1.3	37.5	8.2	226.16	15.3	50.2	2.6	26.0	5.9	204.34
1983/84	44.7	5.5	1.2	40.4	8.1	244.25	14.5	50.4	2.5	27.2	5.4	228.94
1984/85	45.0	5.6	1.3	39.8	8.3	255.46	14.3	50.8	2.5	27.0	5.4	248.30
1985/86	42.1	6.4	1.5	40.6	9.4	241.19	14.1	55.9	2.7	21.3	6.0	240.68
1986/87	42.5	5.8	1.4	42.0	8.3	265.48	15.1	54.5	2.7	22.5	5.3	252.47
1987/88	41.4	5.9	1.4	43.3	8.0	274.54	14.6	54.3	2.6	23.6	4.8	264.84
1988/89	40.7	6.0	1.5	43.9	8.0	263.09	14.3	54.1	2.6	23.9	5.1	263.62
1989/90	42.3	6.4	1.5	41.8	8.0	273.34	15.3	55.0	2.5	22.3	4.9	273.32
1990/91	44.1	6.4	1.4	40.7	7.4	282.38	15.1	55.6	2.3	22.3	4.7	281.58
1991/92	43.9	6.4	1.4	41.6	6.7	283.75	15.2	54.8	2.1	23.4	4.5	280.69
1992/93	44.2	13.4	1.6	33.2	7.6	249.56	14.5	57.2	2.0	20.8	5.6	281.73
1993/94	49.2	13.7	1.7	26.8	8.5	226.42	15.1	58.0	1.7	19.2	5.8	277.91
1994/95	49.3	13.9	1.8	26.7	8.3	234.44	15.0	57.9	1.6	19.4	6.1	292.85
1995/96	47.6	14.0	1.8	28.6	8.0	260.63	14.9	58.2	1.5	19.6	5.7	315.92
1996/97	46.3	13.4	1.8	31.2	7.3	269.15	14.8	57.9	1.5	20.2	5.6	329.10
1997/98	41.9	13.2	1.7	37.3	5.8	313.01	14.4	57.3	1.4	21.7	5.3	362.85
1998/99	40.2	13.2	1.9	39.3	5.5	313.35	12.6	60.0	1.3	21.0	5.1	383.14
1999/00	41.2	13.8	2.0	37.8	5.2	309.76	12.8	59.9	1.3	21.1	4.9	397.12
2000/01	40.2	13.8	2.0	39.2	4.8	321.72	13.0	59.5	1.2	21.6	4.7	418.17
2001/02	39.2	13.8	2.0	40.6	4.4	334.69	13.1	59.1	1.1	22.2	4.6	441.16
2002/03	38.2	13.7	2.0	42.0	4.0	348.63	13.3	58.6	1.0	22.7	4.4	465.98
2003/04	37.2	13.6	2.0	43.5	3.6	363.85	13.5	58.0	1.0	23.3	4.2	493.03
2004/05	36.2	13.6	2.0	44.9	3.3	380.49	13.8	57.5	0.9	23.8	4.0	522.56
2005/06	35.2	13.5	2.0	46.4	2.9	398.69	14.1	56.9	0.9	24.4	3.8	554.86

Table 7.3.10 Share by Energy Sector in each Non-CO_2 Emission (2)

(CH_4) (N_2O)

	CH_4 Industry	CH_4 Transport	CH_4 Other	CH_4 Electricy	CH_4 Energy	CH_4 Total	N_2O Industry	N_2O Transport	N_2O Other	N_2O Electricy	N_2O Energy	N_2O Total
	(Share, %)					($KtCH_4$)	(Share, %)					(KtN_2O)
1981/82	13.9	50.0	24.1	9.9	2.1	4.19	31.3	26.8	16.1	21.2	4.6	0.38
1982/83	13.7	48.3	24.7	11.0	2.3	4.54	31.7	25.0	15.9	22.5	5.0	0.42
1983/84	13.0	49.2	24.0	11.6	2.2	5.03	29.9	25.7	15.6	24.0	4.8	0.46
1984/85	13.0	49.5	23.8	11.5	2.2	5.42	29.7	26.1	15.7	23.7	4.8	0.49
1985/86	12.4	50.7	24.5	10.1	2.3	5.59	28.7	28.2	16.9	20.8	5.3	0.48
1986/87	13.3	49.2	24.6	10.7	2.1	5.85	29.8	26.8	16.7	21.9	4.7	0.52
1987/88	13.7	49.2	24.0	11.1	1.9	6.14	29.3	27.0	16.4	22.8	4.4	0.54
1988/89	13.8	48.7	24.4	11.1	2.0	6.14	28.9	27.0	16.8	22.7	4.5	0.53
1989/90	14.6	49.6	23.3	10.5	1.9	6.42	30.2	27.7	16.2	21.5	4.4	0.55
1990/91	14.4	50.6	22.4	10.7	1.8	6.51	30.5	28.3	15.5	21.5	4.2	0.56
1991/92	15.3	50.6	21.1	11.3	1.8	6.42	31.3	27.9	14.4	22.4	4.0	0.56
1992/93	15.0	52.9	20.5	9.7	2.0	6.40	31.3	30.6	14.7	18.7	4.7	0.53
1993/94	16.3	53.6	19.4	8.7	2.1	6.31	33.5	31.5	14.1	16.0	4.9	0.52
1994/95	15.9	54.0	19.2	8.8	2.1	6.54	33.0	31.8	14.0	16.2	5.1	0.53
1995/96	14.9	55.1	18.8	9.1	2.1	6.97	32.1	32.3	13.5	17.1	4.9	0.57
1996/97	15.7	54.3	18.6	9.4	2.0	7.30	32.5	31.7	13.3	17.9	4.6	0.60
1997/98	15.0	54.4	18.2	10.5	1.8	7.92	30.7	31.5	12.9	20.7	4.2	0.66
1998/99	13.9	56.2	17.9	10.2	1.7	8.48	28.1	33.9	13.1	20.9	4.1	0.68
1999/00	14.2	56.2	17.8	10.2	1.6	8.80	28.6	34.2	13.1	20.3	3.8	0.69
2000/01	14.5	56.1	17.4	10.5	1.5	9.22	28.6	34.1	12.8	20.9	3.7	0.73
2001/02	14.8	56.0	16.9	10.8	1.5	9.68	28.6	34.0	12.4	21.5	3.5	0.76
2002/03	15.2	55.8	16.5	11.1	1.4	10.18	28.7	33.9	12.0	22.1	3.3	0.81
2003/04	15.6	55.6	16.0	11.5	1.3	10.73	28.9	33.7	11.7	22.6	3.1	0.85
2004/05	16.1	55.3	15.5	11.8	1.3	11.33	29.2	33.5	11.3	23.2	2.9	0.90
2005/06	16.6	55.1	15.0	12.1	1.2	11.98	29.5	33.2	10.9	23.7	2.7	0.95

Table 7.3.10 Share by Energy Sector in each Non-CO_2 Emission (3)

(CO) (NMVOC)

	Industry	Transport	Other	Electricity	Energy	Total	Industry	Transport	Other	Electricity	Energy	Total
	(Share, %)					(KtCO)	(Share, %)					(KtNM.)
1981/82	0.6	98.7	0.3	0.3	0.1	765.20	0.3	99.2	0.4	0.1	0.0	143.81
1982/83	0.6	98.6	0.3	0.4	0.1	801.36	0.3	99.2	0.4	0.2	0.0	150.54
1983/84	0.6	98.7	0.3	0.4	0.1	902.17	0.3	99.2	0.4	0.2	0.0	169.51
1984/85	0.6	98.7	0.3	0.4	0.1	978.73	0.3	99.2	0.4	0.2	0.0	183.94
1985/86	0.5	98.7	0.3	0.4	0.1	1,033.39	0.3	99.1	0.4	0.3	0.0	194.44
1986/87	0.6	98.6	0.3	0.5	0.1	1,051.03	0.3	99.0	0.4	0.3	0.0	197.69
1987/88	0.6	98.6	0.3	0.5	0.1	1,102.27	0.3	99.0	0.4	0.3	0.0	207.34
1988/89	0.6	98.5	0.3	0.5	0.1	1,092.46	0.3	98.9	0.4	0.4	0.0	205.52
1989/90	0.6	98.5	0.3	0.5	0.1	1,163.73	0.3	98.9	0.3	0.4	0.0	218.97
1990/91	0.6	98.6	0.3	0.5	0.1	1,204.72	0.3	98.9	0.3	0.4	0.0	226.73
1991/92	0.6	98.5	0.2	0.6	0.1	1,186.45	0.4	98.9	0.3	0.4	0.0	223.24
1992/93	0.6	98.5	0.2	0.5	0.1	1,236.13	0.3	98.8	0.3	0.5	0.0	232.83
1993/94	0.7	98.5	0.2	0.6	0.1	1,234.53	0.4	98.7	0.3	0.6	0.0	232.60
1994/95	0.6	98.5	0.2	0.6	0.1	1,290.23	0.4	98.8	0.3	0.6	0.0	243.12
1995/96	0.5	98.6	0.2	0.5	0.1	1,402.86	0.3	98.9	0.3	0.6	0.0	264.34
1996/97	0.6	98.5	0.2	0.6	0.1	1,448.40	0.4	98.8	0.3	0.6	0.0	272.85
1997/98	0.6	98.6	0.2	0.6	0.1	1,573.45	0.3	98.9	0.3	0.5	0.0	296.33
1998/99	0.5	98.7	0.2	0.5	0.1	1,739.50	0.3	99.0	0.2	0.5	0.0	327.73
1999/00	0.5	98.7	0.2	0.6	0.1	1,804.27	0.3	98.9	0.2	0.6	0.0	340.03
2000/01	0.5	98.6	0.2	0.6	0.1	1,887.74	0.3	98.9	0.2	0.6	0.0	355.77
2001/02	0.5	98.6	0.2	0.6	0.1	1,978.68	0.3	98.8	0.2	0.6	0.0	372.92
2002/03	0.5	98.6	0.2	0.6	0.0	2,074.70	0.3	98.8	0.2	0.6	0.0	391.02
2003/04	0.5	98.6	0.2	0.7	0.0	2,178.08	0.3	98.8	0.2	0.7	0.0	410.51
2004/05	0.6	98.5	0.2	0.7	0.0	2,289.76	0.3	98.7	0.2	0.7	0.0	431.57
2005/06	0.6	98.5	0.2	0.7	0.0	2,410.84	0.3	98.7	0.2	0.7	0.0	454.39

7.3.3 Relationship between Economic Growth, Population and GHG Emissions

Between 1981/82 and 1998/99, GDP in Egypt has increased by about 5.0% annually from 117.6 Billion LE to 268.3 Billion LE. By sector, the Electricity Sector has increased by 8.2% annually--the highest growth rate--followed the Industry Sector has increased by 6.0% annually. The annual growth rate in the Other Sector is 4.9%, and the Transport Sector, 4.3%, the Energy Sector, 2.4% (See Table 7.3.11).

During the same period, the amount of CO_2 emissions has increased by 4.5% annually. The elasticity of CO_2 to GDP is 0.91, which means the increase of CO_2 emissions is smaller than the growth of GDP. The smallest elasticity is the Other Sector, followed by the Industry Sector and the Electricity Sector. The elasticity of the other two sectors is over 1.0--1.2 for the Transport Sector and 1.6 for the Energy Sector. This means that, in growing economic activities, the supply of oil increased and the transportation activity was reinforced without any marked change in energy consumption structure. Of course, in the Industry Sector, the Other Sector and the Electricity Sector, the production and consumption activities were reinforced, too. In this case, these activities were carried out through extending the consumption of electricity and gaseous fuels, which have less intensified CO_2 emissions per GDP.

Table 7.3.11 The Relationship between the Economic Growth and GHGs Emissions

(the Economic Growth) (Unit: Million LE) (CO_2 Emissions) (Unit: $MtCO_2$)

	Industry	Transport	Other	Electricity	Energy	Total	Industry	Transport	Other	Electricity	Energy	Total
1981/82	24,685	8,959	72,082	1,254	10,779	117,759	14.32	11.66	6.92	11.37	2.16	46.42
1982/83	26,669	10,338	77,454	1,383	12,278	128,122	16.08	12.17	7.69	13.85	2.63	52.42
1983/84	28,382	10,721	82,645	1,596	13,874	137,218	16.92	13.71	8.27	16.45	2.75	58.10
1984/85	29,460	10,785	88,517	1,748	16,177	146,687	18.08	14.86	8.88	17.83	2.95	62.60
1985/86	30,984	11,475	92,885	1,992	15,951	153,287	17.12	15.70	9.39	17.81	3.20	63.23
1986/87	32,480	12,003	97,114	2,476	15,344	159,417	19.22	15.95	9.89	19.69	3.02	67.78
1987/88	34,740	12,615	102,604	2,645	14,945	167,549	19.94	16.73	10.12	21.64	3.01	71.44
1988/89	37,077	13,233	106,984	2,809	15,319	175,422	19.42	16.57	10.30	21.95	3.08	71.32
1989/90	39,446	12,334	113,950	2,977	15,135	183,842	21.52	17.67	10.26	22.12	3.16	74.73
1990/91	41,668	12,173	118,104	3,156	15,544	190,645	22.05	18.33	9.99	23.32	3.15	76.84
1991/92	42,214	12,417	120,515	3,298	15,824	194,268	22.32	18.05	9.24	24.27	3.06	76.93
1992/93	43,248	12,913	123,477	3,410	16,077	199,125	21.20	18.96	8.93	23.13	3.37	75.60
1993/94	45,105	13,301	128,264	3,550	16,672	206,892	21.98	18.92	8.26	22.17	3.47	74.80
1994/95	48,368	14,072	133,723	3,763	16,688	216,614	22.83	19.79	8.49	23.39	3.67	78.17
1995/96	51,772	14,945	140,076	3,962	16,688	227,443	24.08	21.57	8.82	25.01	3.78	83.26
1996/97	56,133	16,200	147,093	4,220	15,854	239,500	25.08	22.25	9.16	26.73	3.77	86.98
1997/98	60,869	17,302	153,565	4,469	16,948	253,153	26.72	24.21	9.71	30.23	3.87	94.74
1998/99	66,885	18,357	162,210	4,822	16,067	268,341	25.54	26.80	10.23	31.70	3.95	98.22
1999/00	72,758	19,288	169,636	5,164	16,174	283,021	26.93	27.80	10.52	33.97	3.92	103.14
2000/01	79,023	20,249	177,839	5,527	16,239	298,877	28.51	29.08	10.76	36.93	4.00	109.28
2001/02	85,409	21,171	185,891	5,892	16,373	314,736	30.31	30.48	11.00	40.18	4.07	116.04
2002/03	91,978	22,083	194,091	6,262	16,563	330,978	32.45	31.96	11.24	43.69	4.14	123.47
2003/04	98,808	23,016	202,634	6,644	16,715	347,817	34.89	33.56	11.49	47.55	4.20	131.68
2004/05	105,938	23,987	211,628	7,040	16,830	365,423	37.65	35.28	11.75	51.81	4.25	140.74
2005/06	113,393	25,009	221,144	7,449	16,965	383,959	40.79	37.15	12.02	56.49	4.30	150.74
Average Growth Rates												
(1998/99)/(1981/82)	6.04	4.31	4.89	8.24	2.38	4.96	3.47	5.02	2.33	6.22	3.62	4.51
(2005/06)/(1998/99)	7.83	4.52	4.53	6.41	0.78	5.25	6.91	4.78	2.33	8.61	1.21	6.31
(2005/06)/(1981/82)	6.56	4.37	4.78	7.71	1.91	5.05	4.46	4.95	2.33	6.91	2.91	5.03

(CO_2 Intensity per GDP) (Unit: $KtCO_2$/MillionLE) (Non-CO_2 Gases Intensity per GDP) (Unit: Kt/MillionLE)

	Industry	Transport	Other	Electricity	Energy	Total	SO_2	NO_x	CH_4	N_2O	CO	NMVOC
1981/82	0.580	1.301	0.096	9.065	0.200	0.394	1.66	1.57	35.6	3.2	6.5	1.2
1982/83	0.603	1.177	0.099	10.017	0.214	0.409	1.77	1.59	35.5	3.3	6.3	1.2
1983/84	0.596	1.278	0.100	10.310	0.198	0.423	1.78	1.67	36.6	3.4	6.6	1.2
1984/85	0.614	1.378	0.100	10.202	0.182	0.427	1.74	1.69	36.9	3.4	6.7	1.3
1985/86	0.553	1.368	0.101	8.940	0.201	0.412	1.57	1.57	36.4	3.1	6.7	1.3
1986/87	0.592	1.329	0.102	7.953	0.197	0.425	1.67	1.58	36.7	3.2	6.6	1.2
1987/88	0.574	1.326	0.099	8.182	0.201	0.426	1.64	1.58	36.6	3.2	6.6	1.2
1988/89	0.524	1.252	0.096	7.813	0.201	0.407	1.50	1.50	35.0	3.0	6.2	1.2
1989/90	0.546	1.433	0.090	7.429	0.209	0.406	1.49	1.49	34.9	3.0	6.3	1.2
1990/91	0.529	1.505	0.085	7.390	0.203	0.403	1.48	1.48	34.2	2.9	6.3	1.2
1991/92	0.529	1.453	0.077	7.359	0.193	0.396	1.46	1.44	33.0	2.9	6.1	1.1
1992/93	0.490	1.469	0.072	6.784	0.210	0.380	1.25	1.41	32.1	2.7	6.2	1.2
1993/94	0.487	1.422	0.064	6.246	0.208	0.362	1.09	1.34	30.5	2.5	6.0	1.1
1994/95	0.472	1.406	0.063	6.216	0.220	0.361	1.08	1.35	30.2	2.5	6.0	1.1
1995/96	0.465	1.444	0.063	6.312	0.226	0.366	1.15	1.39	30.7	2.5	6.2	1.2
1996/97	0.447	1.373	0.062	6.335	0.238	0.363	1.12	1.37	30.5	2.5	6.0	1.1
1997/98	0.439	1.399	0.063	6.763	0.228	0.374	1.24	1.43	31.3	2.6	6.2	1.2
1998/99	0.382	1.460	0.063	6.574	0.246	0.366	1.17	1.43	31.6	2.5	6.5	1.2
1999/00	0.370	1.441	0.062	6.578	0.242	0.364	1.09	1.40	31.1	2.5	6.4	1.2
2000/01	0.361	1.436	0.061	6.681	0.246	0.366	1.08	1.40	30.8	2.4	6.3	1.2
2001/02	0.355	1.440	0.059	6.819	0.249	0.369	1.06	1.40	30.8	2.4	6.3	1.2
2002/03	0.353	1.447	0.058	6.976	0.250	0.373	1.05	1.41	30.8	2.4	6.3	1.2
2003/04	0.353	1.458	0.057	7.157	0.251	0.379	1.05	1.42	30.8	2.4	6.3	1.2
2004/05	0.355	1.471	0.056	7.360	0.252	0.385	1.04	1.43	31.0	2.5	6.3	1.2
2005/06	0.360	1.485	0.054	7.584	0.253	0.393	1.04	1.45	31.2	2.5	6.3	1.2
Average Growth Rates												
(1998/99)/(1981/82)	-2.43	0.68	-2.44	-1.87	1.21	-0.43	-2.04	-0.55	-0.70	-1.39	-0.01	0.00
(2005/06)/(1998/99)	-0.85	0.25	-2.10	2.06	0.42	1.01	-1.66	0.17	-0.19	-0.22	-0.45	-0.45
(2005/06)/(1981/82)	-1.97	0.55	-2.34	-0.74	0.98	-0.02	-1.93	-0.34	-0.55	-1.05	-0.14	-0.13

CO_2 intensity per GDP in the Industry Sector has decreased from 0.58 ($KtCO_2$/MillionLE) to 0.38, and CO_2 intensity in the Other Sector has decreased from 0.096 to 0.063. In the Electricity Sector, CO_2 intensity has also decreased from 9.07 to 6.57. On the contrary, CO_2 intensities in the Transport and Energy Sectors has increased from 1.30 to 1.46 and from 0.20 to 0.25, respectively. As the result, the average CO_2 intensity per GDP has been improved by -0.43 % annually between 1981/82 and 1998/99.

The intensity of non-CO_2 gases per GDP has been improved, too. The improvement in intensity of SO_2 is by -2.04 % annually between 1981/82 and 1998/99; NO_x is -0.55 %; CH_4, -0.70 %; N_2O, -1.39 %; and CO, -0.01 %. The improvement in intensity of NMVOC is 0 % in the same period and there was no change.

Generally speaking on the relationship between GDP and CO_2 emissions until the early 1990s, until when Egyptian economy seemed to be stagnated before the rapid recovery began. Reflecting this situation, the energy consumption was also stagnated. Oil consumption, especially, reached the ceiling at the end of 1980s. On the other hand, gaseous fuel consumption has steadily increased. After the early 1990s, energy consumption--both oil and gas--has increased steadily along the economic recovery. CO_2 emission has reflected the economic activity through the changes of the fossil fuel consumption (See Figure 7.3.4 and 7.3.5). CO_2 emissions have the intimate relations with the emission factors of GHGs, and the structural changes from oil to gas means the reduction of the emission factors of GHGs. As a result, the economic activity influenced the structural changes in the energy consumption sources caused the reduction of the CO_2 emission factors.

Figure 7.3.4 Index of GDP, Energy Consumption and CO_2 Emission (1981/82 = 100)

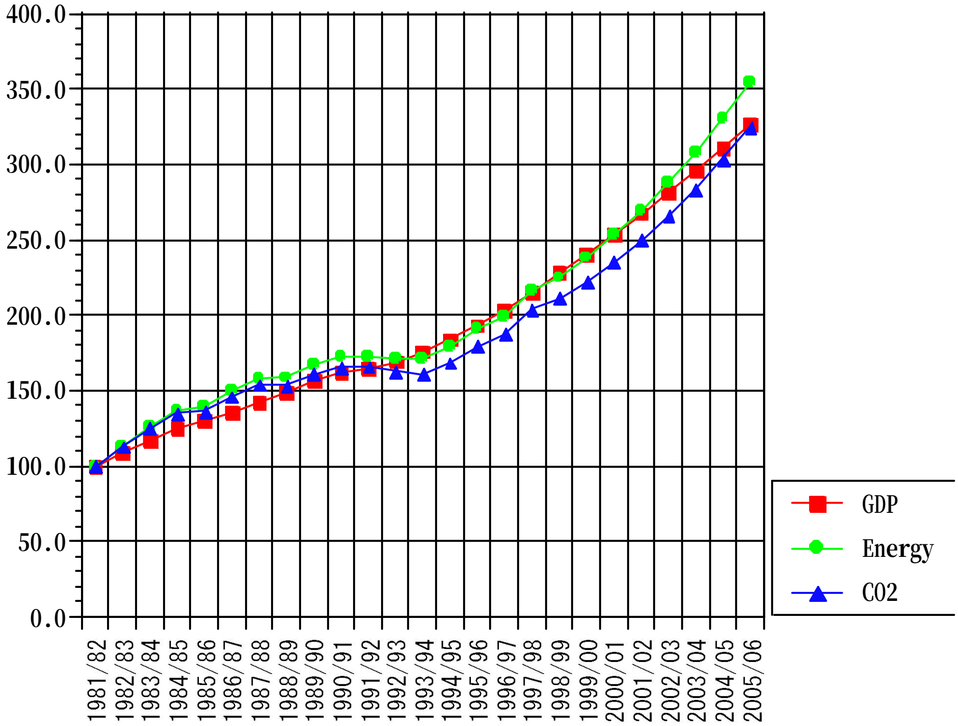
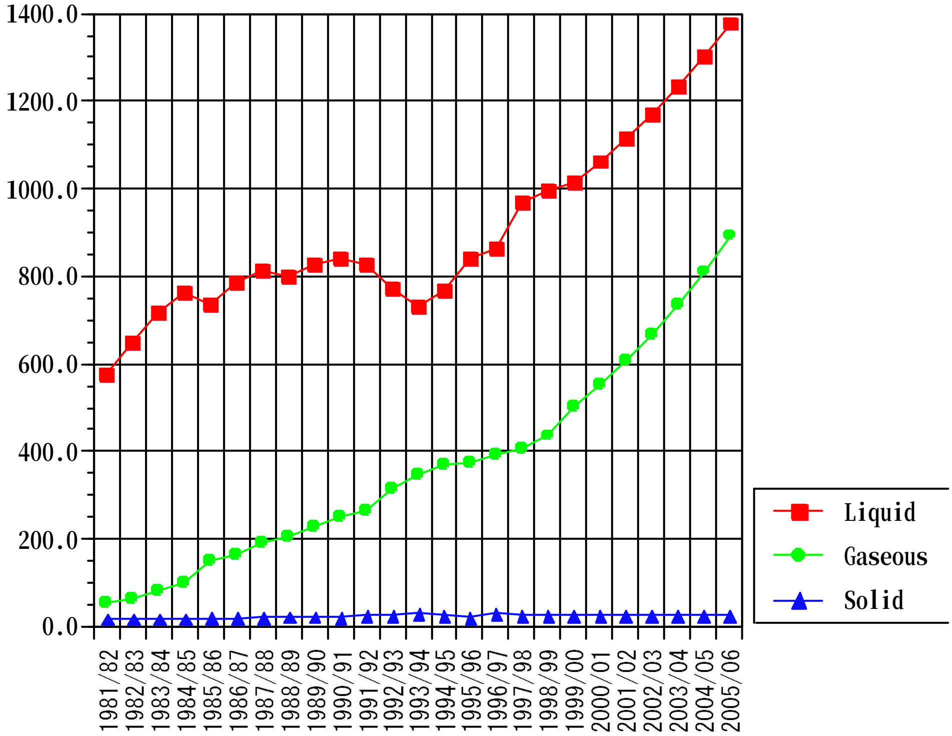


Figure 7.3.5 Energy Consumption by Energy Source

(Unit: TJ)



But this relationship does not mean that the structure will not be changed. In fact, after the early 1990s, the change in structure of energy consumption from oil to gas has become smaller than the change in earlier years, and CO_2 intensity to GDP has been stabilized in the 1990s.

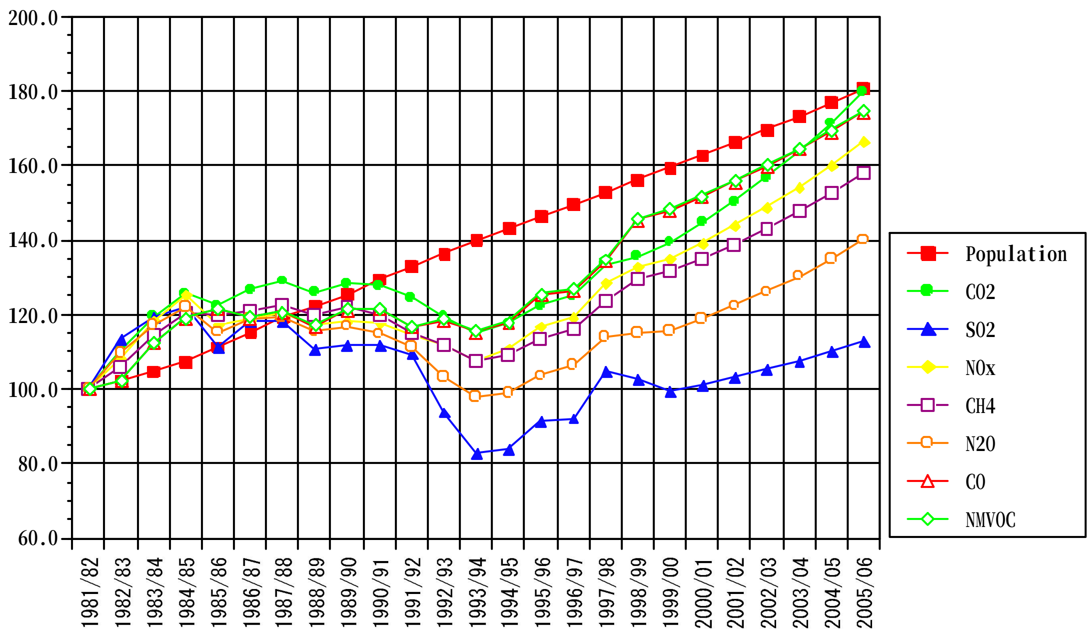
The relationship between GHG emissions and population is as follows. Between 1981/82 and 1998/99, the annual growth rate of population is 2.66%, which is higher than the growth rate of GHG emissions. The CO_2 growth rate is 1.80% annually while SO_2 is 0.17%, NO_x is 1.69%, CH_4 is 1.53%, N_2O is 0.83%, CO is 2.23%, NMVOC is 2.25% (See Table 7.3.12). Figure 7.3.6 shows that the population index curve ascends constantly along the x-axis, but the indices of GHG emissions fluctuates. The fluctuation is a clear reflection of the energy consumption mentioned earlier. GHG emissions have stagnated, reached the ceiling and decreased until the early 1990s, when GHG emissions began to increase although at different rates. SO_2 emissions increase is the smallest among all, and CO and NMVOC emissions increases are the highest (See Figure 7.3.6).

Assuming that the recent situation will continue during the foreseeable future (the Simulation Model), the elasticity of CO_2 to GDP will be over 1.0 as shown in Table 7.3.11.

Table 7.3.12 The Population Growth and GHGs Intensity to Population

	Population	CO_2	SO_2	NO_x	CH_4	N_2O	CO	NMVOC
	1,000	(TCO_2/Cap)	(Kg/Cap)	(Kg/Cap)	(Kg/Cap)	(Kg/Cap)	(Kg/Cap)	(Kg/Cap)
1981/82	42,024	1.105	4.642	4.392	0.100	0.009	18.209	3.422
1982/83	43,024	1.218	5.257	4.749	0.106	0.010	18.626	3.499
1983/84	44,056	1.319	5.544	5.197	0.114	0.010	20.478	3.848
1984/85	45,130	1.387	5.661	5.502	0.120	0.011	21.687	4.076
1985/86	46,766	1.352	5.157	5.146	0.119	0.010	22.097	4.158
1986/87	48,439	1.399	5.481	5.212	0.121	0.011	21.698	4.081
1987/88	50,138	1.425	5.476	5.282	0.122	0.011	21.985	4.135
1988/89	51,307	1.390	5.128	5.138	0.120	0.010	21.293	4.006
1989/90	52,701	1.418	5.187	5.186	0.122	0.010	22.082	4.155
1990/91	54,437	1.412	5.187	5.173	0.120	0.010	22.131	4.165
1991/92	55,893	1.376	5.077	5.022	0.115	0.010	21.227	3.994
1992/93	57,331	1.319	4.353	4.914	0.112	0.009	21.561	4.061
1993/94	58,738	1.274	3.855	4.731	0.107	0.009	21.018	3.960
1994/95	60,138	1.300	3.898	4.870	0.109	0.009	21.454	4.043
1995/96	61,520	1.353	4.236	5.135	0.113	0.009	22.803	4.297
1996/97	62,886	1.383	4.280	5.233	0.116	0.010	23.032	4.339
1997/98	64,263	1.474	4.871	5.646	0.123	0.010	24.485	4.611
1998/99	65,637	1.496	4.774	5.837	0.129	0.010	26.502	4.993
1999/00	67,015	1.539	4.622	5.926	0.131	0.010	26.923	5.074
2000/01	68,422	1.597	4.702	6.112	0.135	0.011	27.590	5.200
2001/02	69,859	1.661	4.791	6.315	0.139	0.011	28.324	5.338
2002/03	71,326	1.731	4.888	6.533	0.143	0.011	29.087	5.482
2003/04	72,824	1.808	4.996	6.770	0.147	0.012	29.909	5.637
2004/05	74,353	1.893	5.117	7.028	0.152	0.012	30.796	5.804
2005/06	75,915	1.986	5.252	7.309	0.158	0.013	31.757	5.985
Average Growth Rates								
(1998/99)/(1981/82)	2.66	1.80	0.17	1.69	1.53	0.83	2.23	2.25
(2005/06)/(1998/99)	2.10	4.12	1.37	3.26	2.89	2.86	2.62	2.62
(2005/06)/(1981/82)	2.49	2.47	0.52	2.14	1.93	1.41	2.34	2.36

Figure 7.3.6 Index of Population and GHGs Intensity to Population (1981/82 = 100)



Intensity per GDP will stay in the same level as in 1998/99. In some cases, the intensity will be higher than the present level. Considering the near future tendency forecast in the Simulation Model, the environment-friendly policy as mentioned earlier will be needed in order to improve the situation of present and near future. At that time, the relationship between Egyptian economic activity, energy consumption and GHG emissions will be improved as the trend transfers the energy from oil to gas.